THE AMERICAN JOURNAL OF ROENTGENOLOGY, RADIUM THERAPY AND NUCLEAR MEDICINE

VOL. 72 AUGUST, 1954 No. 2

CONTENTS

Reflections on the Roentgenologic Diagnosis of Cancer of the Alimentary Tract. HARRY M. WEBER, M.D. 187

Detorsion of Volvulus of the Right Colon: Roentgenographic Considerations. LEO S. FIGIEL, M.D., AND STEVEN J. FIGIEL, M.D. 192

Study of the Sigmoid by Special Roentgenographic Views. ALICE ETTINGER, M.D., AND MILTON ELKIN, M.D. 199

Primary Lymphosarcoma of the Stomach. CORNELIUS COLANGELO, M.D. . 209

Correlation of the Clinical, Pathological and Roentgenological Findings in Diverticulitis. ALEXANDER GOULARD, JR., M.D., AND AUBREY O. HAMPTON, M.D. 213

Herniation through the Foramen of Winslow. ELMER G. ST. JOHN, M.D. . 222

Roentgen Manifestations of Epidural Granulomas of the Spine with a Report of Ten Cases. JOHN A. CAMPBELL, M.D., AND RICHARD A. SILVER, M.D. 229

Roentgenographic Studies of Osteoporosis. II. The Inhibitive Effect of Dietary Phosphate Fertilizer on Dental Caries and Skeletal Decalcification in the Rat. J. GERSHON-COHEN, M.D., AND J. F. MCCLENDON, PH.D. . . 247

Medical Aspects of High Energy Electron Beams. LEWIS L. HAAS, ROGER A. HARVEY, JOHN S. LAUGHLIN, JOHN W. BEATTIE, AND WALTER J. HENDERSON 250

Irradiation of Lymphoid Hyperplasia of the Nasopharynx. ROBERT J. REEVES, M.D. 260

Some Observations Concerned with Carcinoma of the Breast. Part I. MARLYN W. MILLER, M.D., AND EUGENE P. PENDERGRASS, M.D. . . 263

The Role of Cortisone in Preventing Pulmonary Fibrosis Following Irradiation; Preliminary Report. RICHARD M. FRIEDENBERG, A.B., M.D., AND SIDNEY RUBENFELD, M.D., F.A.C.R. 271

Interstitial Radium Treatment of Cancer of the Cervix Uteri; Clinical Appraisal. JAMES A. CORSCADEN, M.D., S. B. GUSBERG, M.D., AND WALTER KOSAR, M.D. 278

Treatment of Tumors of the Pelvic Cavity with Supervoltage Radiation. J. G. TRUMP, SC.D., R. C. GRANKE, B.S., K. A. WRIGHT, B.A., B.S., W. W.

Evans, M.S., Hugh F. Hare, M.D., Earl E. Ewert, M.D., and William L. Conlon, M.D. 284

The Range of Usefulness of Photographic Film in Roentgen Dosimetry. Gerald J. Hine, Ph.D. 293

The Film Method of Tissue Dose Studies with 2.0 Mev. Roentgen Rays. R. C. Granke, B.S., K. A. Wright, A.B., B.S., W. W. Evans, M.S., J. E. Nelson, M.D., and J. G. Trump, Sc.D. 302

Editorials

Electron Beam Therapy. T. Leucutia, M.D. 309

Walter Coit Hill, 1876–1953. George L. Sackett, M.D. . . . 314

Joseph Belot, 1876–1953. James T. Case, M.D. 316

Society Proceedings, Correspondence and News Items 318

Book Reviews 324

Books Received 328

Abstracts of Radiological Literature 331

FABIAN BACHRACH

HARRY M. WEBER

PRESIDENT OF THE AMERICAN ROENTGEN RAY SOCIETY, 1953–1954

THE AMERICAN JOURNAL OF ROENTGENOLOGY
RADIUM THERAPY AND NUCLEAR MEDICINE

VOL. 72 AUGUST, 1954 NO. 2

REFLECTIONS ON THE ROENTGENOLOGIC DIAGNOSIS OF CANCER OF THE ALIMENTARY TRACT*

By HARRY M. WEBER, M.D.
Section of Roentgenology, Mayo Clinic and Mayo Foundation†
ROCHESTER, MINNESOTA

I SUPPOSE an explanation if not an apology should be forthcoming for choosing a topic so nearly exhausted as this one certainly is. Quite by accident, however, the problem of cancer of the alimentary tract has been a preoccupation of mine since the beginning of my career in radiology, and it seemed natural that I would be expected to deal with some phase of it on this occasion.

It is superfluous these days for a radiologist to extol and parade the virtues of his approach to the diagnosis of cancer of the alimentary tract. His colleagues, especially those in medical and surgical gastroenterology, are doing that much more effectively than he could hope to do. He accepts his fellow workers' tributes with gratification but not with complacency; he realizes that his contribution is far from perfect, that it has definite limitations, and that the prospects are not very bright for a substantial improvement in the efficacy of his method for the recognition of cancer of the alimentary tract in a favorable stage for cure. Cure—effective therapy—is after all the ultimate aim of practical medical diagnosis.

The refrain which echoes from our meeting halls and classrooms where the control of cancer is being considered is the same one that was heard a quarter of a century and more ago. "Earlier diagnosis for the earlier institution of eradication" are the words. These days, however, the music seems to be modified more than it was then by overtones of discouragement and frustration. Physicians in general and radiologists in particular either see the patients too late or, far too often, their diagnostic tools and maneuvers, singly and in combination, are not sensitive enough to uncover the disease in a stage before fatal metastasis has taken place.

The proposition that progress in diagnosis has not kept in step with the progress

* President's Address delivered before Fifty-fourth Annual Meeting, American Roentgen Ray Society, Cincinnati, Ohio, September 29 to October 2, 1953.

† The Mayo Foundation is a part of the Graduate School of the University of Minnesota.

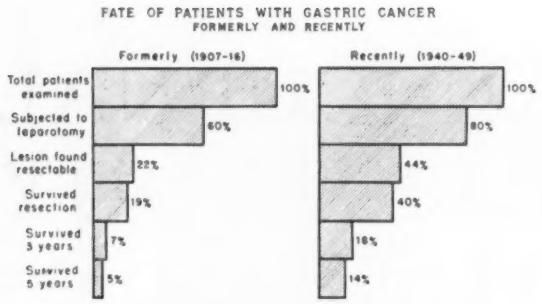


Fig. 1. Improvement of outlook of patients having gastric cancer in 1940–1949 as compared with 1907–1916. (From Berkson, Joseph, Walters, Waltman, Gray, H. K., and Priestley, J. T. Mortality and survival in cancer of the stomach; a statistical summary of the experience of the Mayo Clinic. *Proc. Staff Meet., Mayo Clin.*, 1952, *27*, 137–151.)

made in the treatment of cancer of the alimentary tract is, I think, an easy one to defend. For example, it was shown (Fig. 1) about a year ago that in cases of carcinoma of the stomach the five year survival rate after operation gradually had risen from 5 per cent thirty-five years or so ago to 14 per cent in recent years.[1] This represents an encouraging advance, to be sure, but the net salvage is still depressingly low. The losses sustained were also analyzed in a critical manner (Fig. 2). Five years after the diagnosis of cancer was first made, 86 per cent of the patients were no longer living. Of these, 20 per cent had hopelessly inoperable lesions when they were first observed. When operated upon, 36 per cent of them had lesions that were not resectable, chiefly because demonstrable metastasis already had taken place. Only 4 per cent of them failed to survive the surgical therapeutic procedure. Twenty-six per cent of the patients survived the operation, but did not survive the five year period. I assume that in many of these patients metastasis not demonstrable at the time of operation had nevertheless taken place.

Experience reveals that the prospect for patients with cancer of the large intestine is definitely brighter. It is possible that cancer of this portion of the alimentary tract is being recognized earlier nowadays, but a lower incidence and relatively late development of metastatic extension of intestinal cancer are more logical explanations of the more favorable outlook. On the other hand, the prospect for patients with cancer of the esophagus and for those with cancer of the small intestine continues to be at least as unfavorable as it is for those with cancer of the stomach.

The entire picture is not a particularly gratifying one, nor is it a very encouraging one to contemplate. What can we who are in daily contact with the problem, practicing our specialty presumably to the best of our ability, do to improve the situation even in a small way? Comfort[2] summarized the general suggestions which have been made for the attack on gastric cancer. By analogy these are applicable to cancer of the entire alimentary tract, and I would like to reflect on them for a moment. "The kernel of the problem of increasing the five-year survival rate," Comfort wrote, "consists in getting more patients into the hands of the surgeon while the growth is

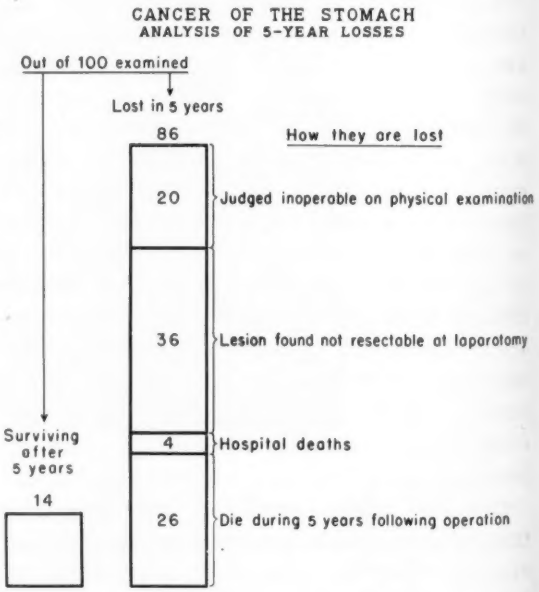


Fig. 2. Analysis of 5-year losses from cancer of the stomach. (From Berkson, Joseph, Walters, Waltman, Gray, H. K., and Priestley, J. T. Mortality and survival in cancer of the stomach; a statistical summary of the experience of the Mayo Clinic. *Proc. Staff Meet., Mayo Clin.*, 1952, *27*, 137–151.)

resectable and before metastases occur." While this may be called an old refrain, it has much greater significance today than ever before, chiefly because advances in surgical technique and skill and in the medical treatment ancillary to them have reduced the morbidity and immediate hospital mortality to a point far lower than could have been anticipated twenty-five years ago.

Comfort went on with his consideration of the suggestions that had come to his attention under the headings of prevention, newer methods of diagnosis, earlier diagnosis, and additional methods of therapy.

Prevention was dismissed quickly as "only a hope."

Additional methods of therapy were considered only long enough to state that they simply do not exist.

Contemplating newer methods of diagnosis and earlier diagnosis, Comfort indirectly but none the less definitely put the heavy hand of responsibility directly on us radiologists. Recognizing the splendid diagnostic yield of our approach, he also called attention to its limitations, and speculated about the possibility of finding in gastroscopy and esophagoscopy, in cytologic examination of gastric washings and scrapings, in certain physicochemical and serologic tests, or in a combination of several of them, a more sensitive procedure for the detection of small and early cancer than the roentgenologic method has proved to be. He did not appear to be very sanguine about the prospects at the moment, but he urged very properly that careful appraisal be given to all of these methods because of the value they might some day prove to have.

Comfort made his conviction clear that in spite of the infirmities the roentgenologic examination is generally recognized to have, it is still the most sensitive and universally applicable test. He speculated on ways and means of getting it applied to more people earlier, at least as soon as the first clinical alteration, however vague and indefinite, is manifest. He called for continuation and intensification of educational programs to elevate the threshold of suspicion both in the public at large and in the medical profession. He also gave thought to screening methods which might be applied to the general population or at least to specific segments of it. Without commenting on the effectiveness of these programs myself, I wish to point out again that in all of them the spotlight is on those who claim special interest and proficiency in roentgenologic diagnosis.

What would happen if radiologists were abruptly confronted with many more patients who are harboring cancer of the alimentary tract in the presymptomatic phase of its pathogenesis? Would a substantial increase in the number of patients successfully treated for the disease be a certain result? I would hesitate to give an affirmative answer to the last question, and would like to allude briefly to some of the misgivings I have about it.

1. I suspect that the number of significant lesions overlooked will remain uncomfortably high. It is logical to assume that the more newly developed a lesion is, the smaller it will be, and the less prominent and definitive will be its roentgenologic manifestations. The smaller the lesion, the more easily it escapes detection, or if it is detected, the less clearly are its critical physical features ascertained. There is reason to suspect that the public, both laymen and professionals, are not sufficiently aware of the limitations that the roentgenologic examination has especially in connection with small lesions. The confidence patients tend to have in the efficacy of the roentgenologic examination tends to be inordinate because they are innocent; that of physicians is sometimes immoderate because they tend to consider only the overall diagnostic efficiency of the method.

Thus an unwarranted confidence has been developed, and I suggest that a way be found to counteract the false sense of security in patient and referring physician engendered especially in instances in which roentgenologic evidence of abnormality

was not elicited. If this is not done, it is possible that the delay in diagnosis will be even greater than it would have been had the roentgenologic examination been performed later when more definite clinical symptoms had been developed, assuming here that at this later time the lesion would be larger and more conspicuous. Unfortunately, delay also provides greater opportunity for metastasis.

2. I am diffident about the prospect of seeing a significant increase in the efficiency of the roentgenologic approach in the diagnosis of cancer of the esophagus in the presymptomatic stage. The quandary is a peculiar one. Frank, very deforming cancer of the esophagus is frequently discovered in patients whose symptoms are surprisingly mild and of very recent development, yet cancer of the esophagus frequently remains too long undetected even when it is causing genuine dysphagia. Where, I ask, in all medical literature, may descriptions of esophageal lesions analogous to the recognized precursors of cancer in other parts of the alimentary tract be found?

3. All roentgenologic examinations of the alimentary tract are poorly adapted to the so-called mass survey. If effective they will continue to be intimate examinations, requiring scrupulous attention, strenuous effort, and adaptation of special procedure by skillful and experienced observers. I foresee no technical advance which will greatly enhance the diagnostic efficiency of roentgenologic examination of the alimentary tract. It is encouraging, however, to note that these considerations are being more generally appreciated, and that the number of competent examiners is being increased year by year.

4. In the small intestine, salvation lies in the relatively low incidence of neoplastic disease in this part of the alimentary tract. The efficiency of the roentgenologic approach is diminished by the inherent difficulty of the examination itself and by the time and effort required to extract its full diagnostic yield. Routine use of this examination in patients not exhibiting significant clinical symptoms would involve an expenditure of time and energy entirely out of proportion to any appreciable reduction in the mortality from cancer of the alimentary tract in general.

Certainly, much needs to be done to make all of our examinations safer for patients and examiners, to expedite and otherwise facilitate our procedures, and to improve our contrast substances and our use of them. These are the lines along which our researches should be renewed and fostered. We can afford to relax only when a test for cancer of the alimentary tract more sensitive than the roentgenologic one appears on the horizon.

A more general appreciation of the menacing character of certain benign-looking lesions should also be fostered. The gospel about the significance of the intestinal polypoid lesion is now quite universally accepted. The colon is being belabored with proctosigmoidoscopic and roentgenologic examination as it never was before, and I am confident that longevity is being increased on that account. It is of only academic interest to repeat that not all intestinal polypoid lesions are or will be cancer, and that not all intestinal cancers begin as polypoid lesions. We, therefore, should be on the alert to discover what may be the first roentgenologic indication of the beginning of those morphologic types of intestinal cancer that did not begin as polypoid lesions. But are we as cognizant of the baleful significance of the gastric ulcer and of the gastric polypoid lesion as we should be? I charge those who are not with contributing to delinquency by entertaining and cultivating too casual an attitude toward recognized precursors of cancer.

Radiologists can make a significant contribution to the diagnosis of early, that is, curable, gastric cancer if at the time of their examination they will temporarily refuse to recognize such a thing as a benign gastric lesion. In my opinion, it is difficult to justify the use of any word in our reports which has any connotation, however re-

mote, of benignancy. This holds for the so-called gastric ulcer, regardless of its size and other physical features, and it holds for the gastric polyp as well. I recognize, of course, that an incidence of malignancy in these lesions of 5 to 15 per cent is low, and that it constitutes a temptation to gamble with probabilities that is often extremely difficult to resist. But the radiologist is not in position to assume exclusive responsibility for the distinction between benign and malignant lesions. It is his professional obligation as a physician not only to recognize the limitations and the capabilities of his method himself, but also to make patients and referring physicians fully aware of them. He may describe, as accurately as he can, the size, shape, contour, and site of the lesions, and the effect he observes them to have on the gastric motility. At the same time, he recognizes his obligation to be certain that both physician and patient appreciate clearly that any suggestion he makes or infers about the possible nonneoplastic nature of these lesions is largely on the basis of statistical probability—a best guess—and in no sense a definitive diagnosis.

In this area of roentgenologic diagnosis, as in any other, it is of utmost importance for the physician to know what he is treating. That is the reason why it is so imperative to get ulcerating and polypoid lesions of the stomach to surgical exploration quickly. The true nature of these lesions is often revealed only by microscopic examination.

Radiologists can accept with equanimity and confidence the challenge presented by the diagnosis of curable cancer. They also must have a resolute determination to extract the maximal yield of their method each time a patient presents himself for examination. Proficiency and dexterity in this field of diagnosis are an art, but they are chiefly an acquired skill which demands no special virtuosity other than the habit of intense effort, dogged patience, and an objective attitude. These virtues we are obligated to practice and to teach by precept and example.

Mayo Clinic
Rochester, Minnesota

REFERENCES

1. Berkson, Joseph, Walters, Waltman, Gray, H. K., and Priestley, J. T. Mortality and survival in cancer of the stomach; a statistical summary of the experience of the Mayo Clinic. *Proc. Staff Meet., Mayo Clin.*, 1952, *27*, 137–151.
2. Comfort, M. W. The problem of gastric cancer from the viewpoint of the internist. *Proc. Staff Meet., Mayo Clin.*, 1952, *27*, 151–156.

DETORSION OF VOLVULUS OF THE RIGHT COLON*

ROENTGENOGRAPHIC CONSIDERATIONS

By LEO S. FIGIEL, M.D., and STEVEN J. FIGIEL, M.D.

DETROIT, MICHIGAN

IN A recent survey of the literature, we found no references pertaining to the roentgenographic demonstration of detorsion, spontaneous or conservatively induced, of volvulus of the right colon.

Publications[1,2,3,5,7,9,12,15,17,18] on the subject of volvulus of the cecum and ascending colon frequently mention that many patients recall previous sudden attacks of abdominal pain, distention and vomiting, followed by spontaneous relief of these symptoms; thus the suspicion of recurrent volvulus with spontaneous detorsion may be justified.

Analogous experiences with sigmoid volvulus are familiar to clinicians, but, in addition, roentgeographic demonstrations of detorsion, spontaneous or induced by barium enema study, rectal intubation or special positioning have been published.[7,10,11,13]

We have observed 3 cases of volvulus of the cecum and ascending colon in which detorsion was demonstrated roentgenographically. In 2 instances, such detorsion occurred at the time of a colonic examination by barium enema study. In the third and most recent case, volvulus occurred as a postpartum complication, and detorsion was effected by placement of the patient in the knee-chest position.

Roentgenologic criteria for the diagnosis of volvulus of the cecum and ascending colon have been recently published by the authors.[5,6]

Summarizing briefly, one may encounter volvulus of the cecum and ascending colon with complete or partial obstruction. The abnormally rotated colonic segment may retain its usual location or it may become displaced to a more or less ectopic position within the abdomen. Most often the combination of complete obstruction with displacement of the cecum to an ectopic position prevails. In such cases, the roentgen features are quite characteristic, and diagnosis of volvulus is a fairly simple procedure.

Demonstration of an abnormally dilated intestinal segment, possibly colonic, often identifiable as cecum, in proximity to the apparent proximal termination of the right colon during the course of barium enema study should immediately suggest that the cecum may not have been filled, and may be obstructed. Abnormal disposition of the cecum (distended gas pocket) in the presence of obstruction, demonstrated on the barium enema study, must force one to seriously consider the possibility of torsion effects.

We are presenting 3 instances of detorsion of a volvulus of the cecum. In 2 of our cases, examination of the colon with a barium enema revealed a complete obstruction in the ascending colon distal to an abnormally distended segment of bowel. In Case I the distended segment was readily identifiable as cecum and was located high in the right upper quadrant with displacement of the proximal half of a very redundant transverse colon superiorly. In Case II, a large gas pocket was identified in the right mid-flank in proximity to an abnormal termination and deviation of the barium column. In both cases, on evacuation of the enema, filling of the cecum developed with return of this part to its normal position and orientation with disappearance of the gas pocket previously noted. Only one conclusion is possible in such cases: detorsion of a volvulus of an abnormally mobile cecum.

In our third case a tentative diagnosis of

* From the Department of Radiology, Grace Hospital, Detroit, Michigan.

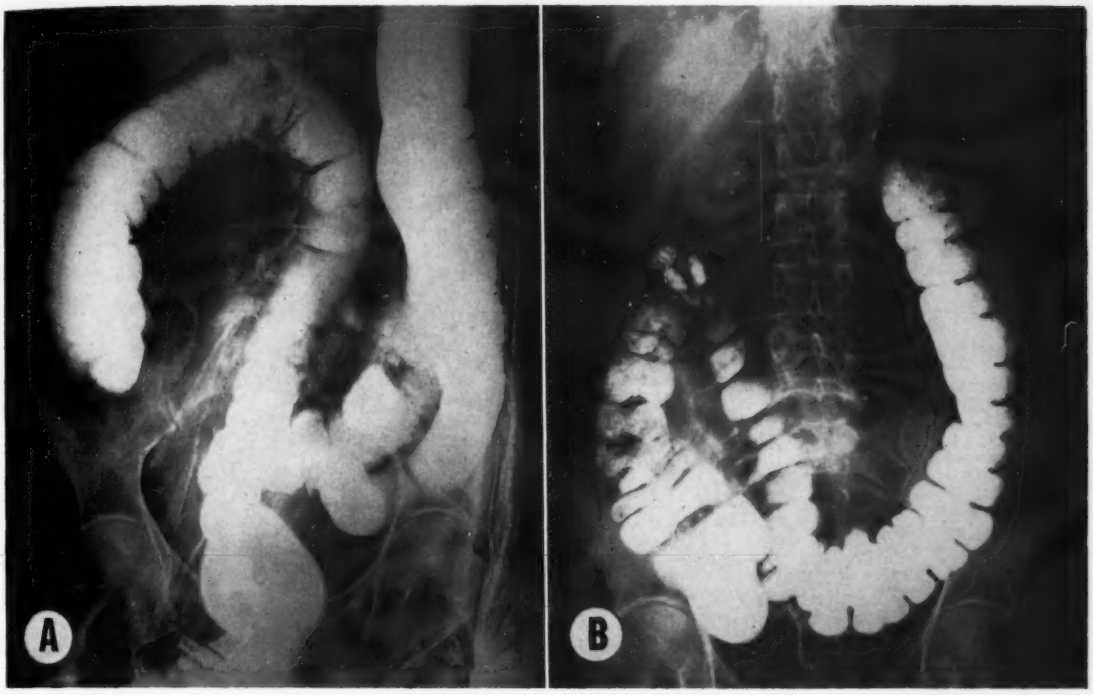


Fig. 1. Case 1. (*A*) Note the distended gas pocket in the right mid-flank and upper abdomen with preservation of haustrations and the obstruction in the ascending colon. (*B*) The postexpulsion study shows the disappearance of the gas pocket noted in (*A*) and the filling of a long hyperdescended cecum which assumes a position in the right lower abdomen.

volvulus of the ascending colon was made on the basis of the original survey films of the abdomen; this assumption was verified by barium enema study. Because the torsion was a postpartum complication and had existed only a short time, an attempt at conservative treatment with placement of the patient in a suitably supported knee-chest position was advised by the attending radiologist,* hoping that the combination of a very relaxed abdominal wall and the effects of a knee-chest position would result in a detorsion. Subsequent events proved that such had occurred.

REPORT OF CASES

Case 1. S. S., a white woman, aged seventy, was admitted on November 17, 1952, with sudden onset of cramping lower abdominal pain of four days' duration; no bowel movements during the past two days. Physical examination revealed minimal tenderness in the right lower quadrant.

November 17, 1952. No evidence of small or large intestinal obstruction on a survey study of the abdomen. No unusual gas pockets were seen.

November 18, 1952. Barium enema study revealed a complete obstruction in the mid-portion of the ascending colon with a severely distended colonic segment, presumably cecum, lying in the right upper abdomen, and displacing the proximal half of a redundant transverse colon cephalad.

After partial expulsion of the enema, the previously displaced and distended segment had shifted to the right lower quadrant and pelvis; the obstruction was found relieved; the distention alleviated; the orientation corrected. The segment could be recognized as a very mobile, hyperdescended cecum which had previously undergone abnormal torsion and now had returned spontaneously to its normal position.

Following this examination, the patient's condition improved immediately and she was discharged on November 22, 1952. No surgical intervention was contemplated.

* Dr. H. A. Jarre, Director of Department of Radiology, Grace Hospital.

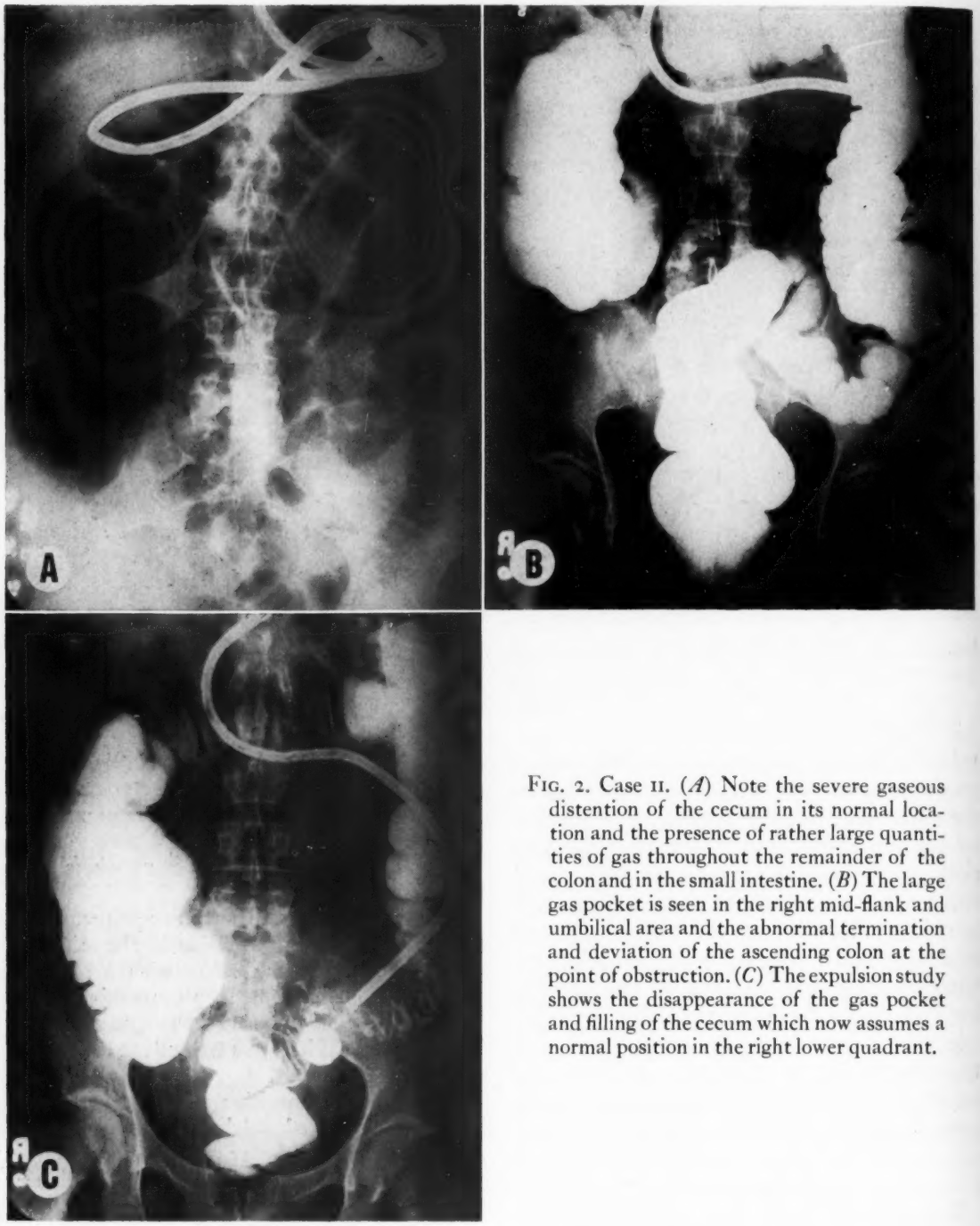


FIG. 2. Case 11. (*A*) Note the severe gaseous distention of the cecum in its normal location and the presence of rather large quantities of gas throughout the remainder of the colon and in the small intestine. (*B*) The large gas pocket is seen in the right mid-flank and umbilical area and the abnormal termination and deviation of the ascending colon at the point of obstruction. (*C*) The expulsion study shows the disappearance of the gas pocket and filling of the cecum which now assumes a normal position in the right lower quadrant.

Comment. Roentgenographic features indicate volvulus of the cecum and lower ascending colon with marked displacement. Detorsion occurred during a roentgen examination by means of a barium enema.

Absence of abnormal distention on the survey study of November 17, 1952, would indicate probable absence of a pathologic obstructive process at the time of examination. It has been our experience that pathologic distention with gas and fluid occurs as early as four hours following the onset of

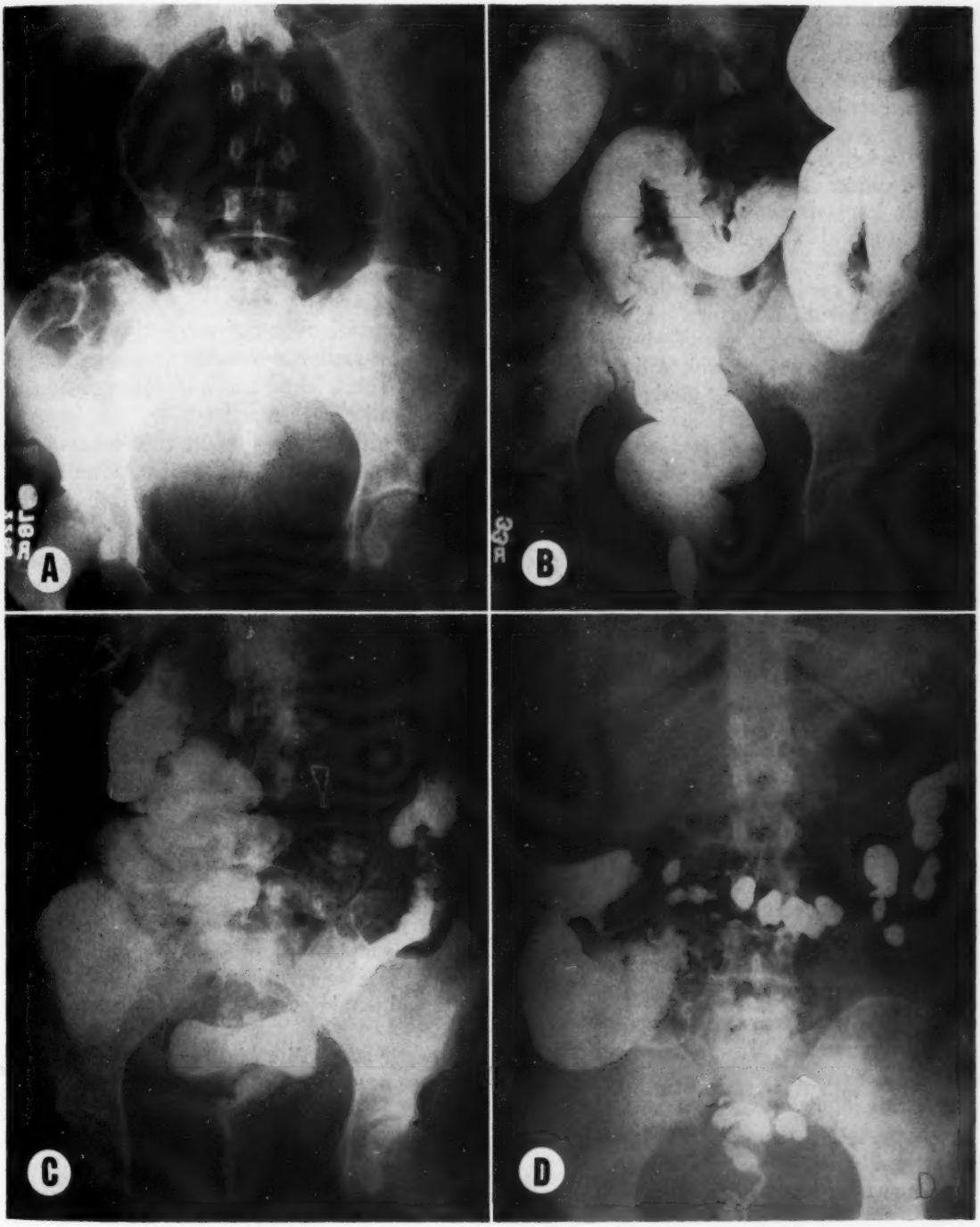


Fig. 3. Case III. (*A*) Note the dilated colonic segment in the mid-upper abdomen, assuming a somewhat reniform appearance with the concave surface on the right. Note the concentration of small intestinal loops in the right abdomen and the apparent ileocecal insertion at the right inferior aspect of the dilated colonic segment. (*B*) The obstruction is shown in the mid-ascending colon on the barium enema study. (*C*) Note the partial filling of the previously completely obstructed right colonic segment and the persistent transposition of the right colonic segment. A narrowing of the colonic lumen is visible at the point of torsion in the mid-ascending colon. (*D*) This shows the normal orientation of a redundant right colonic segment, which has decreased considerably in size since the earlier studies.

symptoms in cases of cecal volvulus.

CASE II. B. V., a white woman, aged fifty, was admitted on December 17, 1946, acutely ill, nauseated and vomiting. No previous surgery.

Forty-eight hours prior to admission she had noticed sudden, generalized cramping abdominal pain increasing in severity, most marked in the right side. No bowel movements for two or three days.

Physical examination revealed marked abdominal distention, generalized tenderness, most severe in the right mid-flank. Hyperactive peristaltic activity was visible and audible.

Initial roentgenographic study of the abdomen undertaken on the following morning revealed a marked cecal distention with normal orientation of the cecum. Moderate quantities of gas were present throughout the remainder of the colon. Rather severe distention of small intestinal loops was present.

Following decompression of the small intestine by means of a long tube, a barium enema study was done on December 20, 1946. This study revealed an obstruction at the mid-ascending colon in proximity to a large gas pocket which was located in the right mid-flank. Immediately after the enema, the patient's condition improved and a small intestinal series on the following day revealed no evidence of obstruction or abnormality.

Comment. It has been our experience that in cases of partial torsion (180 degrees or less) of the cecum and ascending colon, in which the cecum remained normally oriented in position, considerable gas was present throughout remaining portions of the colon, indicating an incomplete or partial obstruction. Early and accurate diagnosis is extremely difficult in these cases unless one is very conscious of the possibility of partial torsion with incomplete obstruction.

It has also been our experience in this group of cases that the extreme delay in diagnosis, clinically and roentgenographically, has resulted in a significantly higher mortality than in those cases of volvulus of the right colon wherein complete obstruction was present.

On the original survey study the rather marked cecal distention and the normal cecal position should be noted. Presence of moderate quantitites of gas throughout the remainder of the colon makes it extremely difficult to localize the site of obstruction.

The pre-evacuation barium enema study demonstrated an obstruction in the ascending colon with an abnormal termination and deviation of the ascending colon in relation to a large gas pocket which was located in the right mid-flank and periumbilical area.

On partial evacuation of the enema, a normally situated cecum was filled with barium and the gas pocket previously noted had disappeared.

A significant finding in this case is the change in position of the obstructed cecal segment from its normal location to the right mid-flank. Demonstration of change in the position of a severely distended cecal segment should cause the observer to consider torsion displacement.

Filling of the cecum with a return to its normal orientation, with disappearance of the gas pocket on the expulsion study, permits only one conclusion, that is a volvulus of the right colon which was reduced during the expulsion phase of the enema.

CASE III. D. K. a white woman, aged twenty-nine, developed abdominal distention immediately following delivery of her second child on January 31, 1953, followed by generalized cramping abdominal pain and vomiting.

On physical examination, localized distention and tenderness was noted in the epigastrium.

Roentgenologic Examination. On February 3, 1953, survey studies of the abdomen revealed a severely distended right colonic segment in the mid-portion of the abdomen with multiple distended small intestinal loops lying laterally to the right of the cecum. Transposition or reversal of the contours of this segment was noted, and a right ileocolic insertion suggested. There was complete absence of distention of the remainder of the colon. Tentative diagnosis: volvulus of the cecum and ascending colon with displacement and complete obstruction.

Barium enema examination revealed a complete obstruction in the mid-ascending colon consistent with torsion.

Course. In view of the patient's fairly good condition and in the presence of an extremely relaxed anterior abdominal wall (postpartum state), the attending radiologist suggested that an attempt at detorsion be made by placement of the patient in the knee-chest position with special supports at the chest and thighs. A roentgenologic re-evaluation of the obstructive process after an interval of a few hours was proposed.

Re-examination of the abdomen after four to five hours of the indicated conservative treatment revealed relief of distention of the right colonic segment which was found filled with barium which, however, showed a persistent reversal of its contours (convex medially) and a slight narrowing of the lumen at the site of torsion, indicating that detorsion of the volvulus was still incomplete.

At this time the patient felt improved and was passing considerable gas rectally.

Special positioning of the patient was continued and a roentgenographic review of the abdomen on February 4, 1953, revealed a marked decrease in the size of the cecum with establishment of normal orientation of a redundant cecum in the right lower abdomen. The patient was discharged on February 5, 1953.

Comment. To our knowledge, this is the first roentgenographic demonstration of a planned, conservatively induced detorsion of a volvulus of the right colon effected by positioning of the patient.

On the basis of this observation, it would appear advisable to attempt special positioning as a therapeutic measure in the treatment of early, uncomplicated volvulus of the colon, especially in patients with lax abdominal walls. However, we must emphasize that close and prolonged roentgenographic and clinical observation will be necessary as surgical intervention is indicated, if detorsion cannot be accomplished by this method in a few hours.

The implications of proper interpretation of the detorsion mechanism in cases such as we have presented is readily obvious.

If one were to assume recurrent attacks of cecal volvulus from an analysis of the patient's history, one should consider seriously some surgical procedure to prevent this serious occurrence. Fixation of the abnormally mobile right colon or resection might be advisable. After spontaneous detorsion a selective interval operation is feasible.

SUMMARY

Three cases of volvulus of the right colon are presented, two of which were reduced at the time of expulsion of a barium enema study being performed for diagnostic purposes; the third was reduced by special positioning of the patient in the knee-chest position.

Suitable roentgenographic studies pertinent to a discussion of these cases are presented.

Criteria for diagnosis are briefly discussed and implications of accurate interpretation stressed.

Advisability of barium enema study for diagnostic confirmation in cases of suspected volvulus is augmented by its effect in detorsion of certain cases.

Special positioning in the knee-chest position can safely be considered as a potential therapeutic measure in certain selected cases. Advisability of close observation of these cases is emphasized.

Leo S. Figiel, M.D.
Department of Radiology
Grace Hospital
Detroit 1, Michigan

The authors are extremely grateful to Dr. H. A. Jarre for his guidance and assistance in the preparation of this paper.

REFERENCES

1. Browne, D. C., and McHardy, G. Acute and chronic cecal volvulus. *Am. J. Digest. Dis.*, 1942, *9*, 117–180.
2. Courty, A. Les volvulus aigus du colon droit. Masson & Cie, Paris, 1950.
3. Dixon, C. F., and Meyer, A. C. Volvulus of cecum. *S. Clin. North America.*, 1948, *28*, 953–963.
4. Donhauser, J. L., and Atwell, S. Volvulus of cecum; with reviews of one hundred cases in literature and report of six new cases. *Arch. Surg.*, 1949, *58*, 129–148.
5. Figiel, L. S., and Figiel, S. J. Volvulus of

cecum and ascending colon. *Radiology*, 1953, *61*, 496–515.

6. Figiel, L. S., and Figiel, S. J. Studies on intestinal obstruction. Six cases of volvulus of cecum and ascending colon. *Grace Hosp. Bull.*, 1953, *31*, 3–13.
7. Frimann-Dahl, J. Roentgen Examinations in Acute Abdominal Diseases. First edition. Charles C Thomas, Publisher, Springfield, Ill., 1951.
8. Gerwig, W. H., Jr. Volvulus of colon. *Arch. Surg.*, 1950, *60*, 721–742.
9. Golden, R. Radiological Examination of the Small Intestine. J. B. Lippincott Company, Philadelphia, 1945, p. 182.
10. Hamlin, E. Jr. Nonoperative reduction of acute volvulus of sigmoid. *New England J. Med.*, 1952, *247*, 835–837.
11. Hinton, D., and Steiner, C. A. Recurrent volvulus of sigmoid colon; unusual case report. *Ann. Surg.*, 1942, *116*, 147–149.
12. Ingelfinger, F. J. Intermittent volvulus of mobile cecum. *Arch. Surg.*, 1942, *45*, 156–163.
13. Melamed, A. Volvulus of megacolon reduced during barium enema examination. *Radiology*, 1945, *45*, 392–395.
14. River, L. P, and Gubler, J. A. Transverse megacolon associated with chronic volvulus; case report. *Ann. Surg.*, 1943, *117*, 786–790.
15. Sweet, R. H., Volvulus of cecum; acute and chronic with reports of 8 cases. *New England J. Med.*, 1935, *213*, 287–293.
16. Young, E. L., Morrison, H. R., and Wilson, W. E., Jr. Volvulus of cecum and ascending colon. *New England J. Med.*, 1947, *237*, 78–86.
17. Wangensteen, O. H. Intestinal Obstruction. Second edition. Charles C Thomas, Publisher, Springfield, Ill., 1942.
18. Wolfer, J. A., Beaton, L. E., and Anson, B. J. Volvulus of cecum; anatomical factors in its etiology. *Surg., Gynec. & Obst.*, 1942, *74*, 882–894.

Vol. 72, No. 2

STUDY OF THE SIGMOID BY SPECIAL ROENTGENOGRAPHIC VIEWS*

By ALICE ETTINGER, M.D., *and* MILTON ELKIN, M.D.
BOSTON, MASSACHUSETTS

CANCER of the colon is not only a common disease but, if detected reasonably early, has a respectable cure rate. The responsibility for diagnosis of lesions of the colon rests with roentgenological and proctological methods. Boehme and Hanson,[5] in a study of 1,457 patients operated on at the Lahey Clinic found that of cancers of the colon above the rectum, 46.9 per cent occurred in the rectosigmoid and sigmoid. In general, it is felt that the rectum and the lower portion of the sigmoid are best investigated by rectal examination and endoscopy, whereas the higher regions of the colon are best studied by roentgenologic methods. It has been stated[4] that the roentgen diagnosis of cancer of the colon, with the exclusion of the rectum, is correct in about 90 per cent of the cases; *i.e.*, of 100 patients in whom enough clinical symptoms exist to warrant exploratory surgery, in 10 the diagnosis had either been missed or a lesion found and misinterpreted by the radiologist.

Completely satisfactory examination of the sigmoid may be difficult to accomplish. The sigmoid has many variations. The straight sigmoid poses no great problem; this type can be easily and thoroughly studied by both the endoscopic and roentgenologic methods. However, the redundant multicoiled sigmoid is a challenge to both the endoscopist and the radiologist. It is our intent in this paper to review the methods available to the radiologist for more adequate study of the rectosigmoid and sigmoid. It is generally agreed that careful rotation of the patient during slow filling of the colon at the time of roentgenoscopy offers the best method of roentgenological investigation of the rectosigmoid and sigmoid, provided the examination is performed by a skillful, experienced roentgenoscopist and provided the filling is slow enough to allow observation of the head of the barium column at all times before the loops are superimposed. Since so-called routine anteroposterior or posteroanterior views do not usually demonstrate the rectosigmoid and sigmoid adequately, several special views have been resorted to in an attempt to uncoil these parts of the colon. We have no new views to add, but have surveyed the roentgenographic techniques available and their applications.

Gray's Anatomy[8] assigns the third sacral segment as the level of the boundary between the rectum and the sigmoid. The sigmoid has been arbitrarily subdivided into pelvic and iliac portions. The pelvic part is described as a loop of bowel averaging 40 cm. in length, which beginning at the superior aperture of the true pelvis passes transversely across the front of the sacrum to the right side of the pelvis, where it curves on itself to turn to the left to reach the midline at the level of the third sacral segment, where it bends downward to become the rectum. The loop, being completely surrounded by peritoneum and having a mesentery (sigmoid mesocolon) of variable length, is fixed at its ends, with considerable range of movement in its central portion. Inasmuch as the two extremities of this 40 cm. loop are only about 3 to 10 cm. apart, the position and course of the loop have great individual variation.

The iliac portion of the sigmoid, lying in the left iliac fossa, is shorter, measuring 12 to 15 cm.; it begins at the level of the iliac crest as a continuation of the descending colon and curves downward and medialward to end in the pelvic portion.

* From the Departments of Radiology, New England Center Hospital and Tufts College Medical School, Boston, Massachusetts.

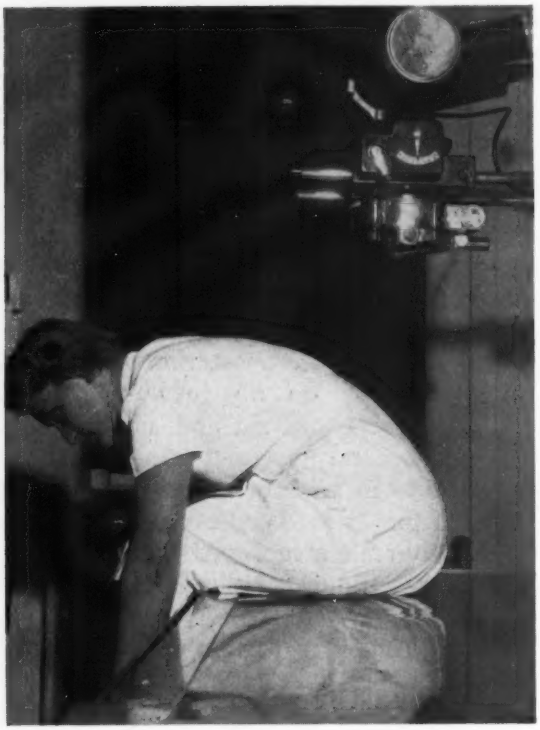


FIG. 1. Positioning of the patient for the Chassard-Lapiné projection.

This subdivision of the sigmoid is covered by peritoneum on its sides and anterior surface only, having no mesentery and thus being fixed. The fact that it is fixed makes its roentgenologic study comparatively simple.

Hence, from a purely mechanical viewpoint the problem is that of examining a continuous tube about 70 cm. long, fixed at each end for a distance of about 15 cm. and having a variably coiled movable midportion of about 40 cm. For the two fixed ends, which are quite constant in position, stereotyped methods of examination may be successfully devised. The examining finger and various sized endoscopes can study the lowermost parts of this tube. The roentgenologist may devise standard positions for roentgenographing the iliac colon; however, in dealing with the meandering pelvic portion, the radiologist must often desert stereotypy for virtuosity.

The true lateral view of the filled and evacuated bowel has been advocated for study of the rectum and rectosigmoid.[2,10,12,15] This technique usually gives a good view of the rectum and lowermost portion of the pelvic portion of the sigmoid, inasmuch as the central beam is perpendicular to their longitudinal axis and separates the posteriorly placed rectum from the overlying sigmoid, but it is of no great value in separating the segments of the multicoiled sigmoid loop where the beam is parallel to a large portion of these loops. Oblique views have been used to separate sigmoid coils, the degree and direction of the obliquity being determined at time of roentgenoscopy.[1,2,7,14] Air contrast studies, especially with stereoscopic films, have often effected improved visualization of the sigmoid.[13,15] In occasional cases, the supine Trendelenburg position allows the sigmoid to fall partially into the false pelvis with separation of some of the loops.[7] Billing[3] advocated the performance of the barium enema with a full urinary bladder, the latter pushing the redundant loops of sigmoid from the true pelvis and thus unfolding them. Stewart and Illick[14] had previously suggested that distention of the urinary bladder with air or water would allow better study of the sigmoid in a number of difficult cases. A further refinement of this method is an angled left oblique view; *i.e.*, after the urinary bladder has been filled (with saline or water by catheter or by refraining from urination) and the rectum and sigmoid filled with barium, the patient is rotated to the left (left posterior oblique) and the beam tilted about 35° to the head.[3]

In 1923 Chassard and Lapiné[6] described a new roentgenographic position for studying the pelvic outlet in pelvimetry. In 1951 Raap[11] described the use of the Chassard-Lapiné position for studying the pelvis and its contents. The patient is placed at right angles to the axis of the table at its midpoint with the popliteal areas closely applied to the edge of the table; he bends forward until the undersurface of the symphysis pubis and the ischial tuberosities are equidistant from the film; *i.e.*, the pubic

arch is horizontal. The position of flexure is maintained by the patient's grasping the ankles with the hands during the exposure. A 14 by 17 inch film has already been placed in the Bucky tray at right angles to the anteroposterior plane of the pelvis. The central ray passes through the spine and sacrum (Fig. 1). Roentgenographic factors are practically the same as those for a lateral projection of the pelvis. Raap emphasized the use of this position in the study of the colon, especially of the sigmoid. He stated that inasmuch as the folding and overlapping of the coils of bowel occur in a horizontal plane, a projection at right angles to the usual angles should be of value; it especially allows a study of the anterior and posterior surfaces of such coils. Raap has used the Chassard-Lapiné projection with the colon empty or full, including barium enema or air.

The point we wish to make is that for complete roentgenographic visualization of the rectum, rectosigmoid and sigmoid there are a number of techniques available. There is no one position which is best for all patients. We are not suggesting that it is feasible or advisable to attempt all the projections in every roentgen study of the colon. The mainstay of the barium enema examination is careful roentgenoscopy, spot filming, and pre- and postevacuation survey films. In addition, it is wise to make a record of the sigmoid loop by obtaining an oblique or lateral film of this area during the filling, the degree of obliquity for optimal visualization of the sigmoid being determined roentgenoscopically. There are difficult cases, however, where more effort should be expended—such as, very obese patients in whom because of dimness of the image roentgenoscopy is unreliable; patients in whom the examiner is not entirely satisfied with his roentgenoscopic study of the sigmoid because of multiple coils; patients with a redundant sigmoid in whom a neoplasm of the colon is highly suspected clinically and where the routine examination has failed to show a lesion. It is for such cases that the radiologist should

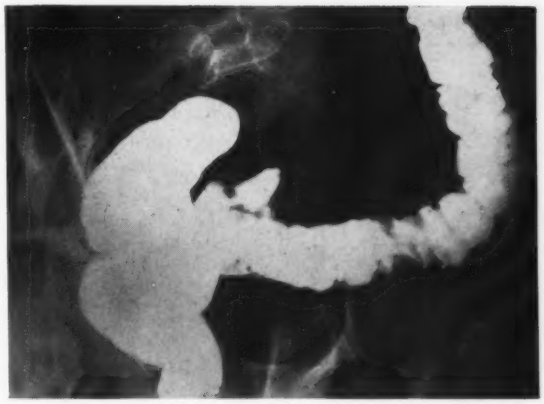


Fig. 2. Case 1. Left posterior oblique view. Lesion not seen.

avail himself of the various techniques which we have summarized. After some experience, the roentgenoscopist may be able to appraise the anatomical situation leading to the difficulty in each case and be able to suggest the best position for that case—whether the position be lateral, oblique, angle oblique, angle anteroposterior or Chassard-Lapiné.

The following cases are meant to illustrate the potentialities of the various positions:

Case 1. O.A.T., a fifty-two year old house painter, had had intermittent lower abdominal cramps for four years, worse during the past month. Roentgen studies of the upper and lower gastrointestinal tract performed elsewhere one year ago were reported as negative. On several occasions, especially for the six months preceding this admission, he had noted blood mixed with the stool. His movements have been smaller and more frequent than previously. He has lost 10 lb. in weight in three weeks. Rectal examination was negative except for a strongly positive guaiac test on the finger specimen. Sigmoidoscopy to 24 cm. showed no lesions. The history was very suggestive of a neoplasm of the colon. The sigmoid was carefully studied during slow filling, although with some difficulty due to overlapping coils. A persistent narrowing was visualized in the region of the rectosigmoid, and a roentgenoscopic diagnosis of cancer of the sigmoid was made; however, because of the difficult anatomy, the entire extent of the lesion could not be demonstrated on spot

FIG. 3. Case I. Right posterior oblique view. Lesion not seen.

films to the roentgenoscopist's satisfaction. The more usual projections—anteroposterior, left lateral, left posterior oblique (Fig. 2), and right posterior oblique (Fig. 3)—failed to reveal the lesion. However, the angled right posterior oblique projection (Fig. 4) demonstrated the narrowed lumen with the proximal overhanging shelf. Subsequent operation confirmed the diagnosis of cancer of the sigmoid. Here the special view was the only one which provided the desired roentgenographic confirmation of the extent of a lesion that had been seen roentgenoscopically.

CASE II. R.E.D., a man, aged fifty-five, has had a fullness of the right hypochondrium for four months, unrelated to food. For years he has had two bowel movments daily, with no recent change. However, for six years there has been occasional streaking of the stool with bright red blood, thought due to hemorrhoids. For two months he has noticed considerable mucus and an increased amount of blood, often well mixed with the stool. Also, for the past few weeks his stools have been small in caliber and hard. There has been a weight loss of 12 lb. in four months. By physical examination, the liver was markedly enlarged, its edge being four fingerbreadths below the right costal margin. Rectal examination was negative except for gross blood in the finger specimen. Sigmoidoscopy to 26 cm. showed no lesions. In this instance the lesion was seen during roentgenoscopy as a filling defect of the pelvic sigmoid without marked alteration of the outline of the barium-filled colon in that area. The lesion could not be seen on the slightly oblique filled film (left posterior oblique) (Fig. 5) or on the lateral view (Fig. 6). However, the tumor was readily seen on the Chassard-Lapiné view (Fig. 7) arising from the anterior wall and not completely encircling the bowel. It is because of its involvement of only a portion of the circumference of the colon that the lesion was so easily obscured by the dense barium in the oblique and lateral views. Yet, the Chassard-

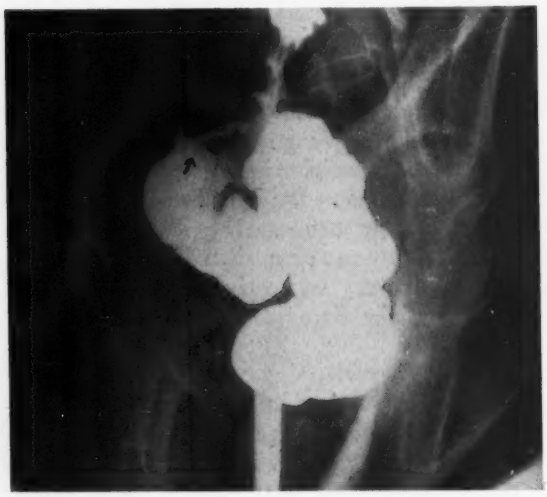


FIG. 4. Case I. Angled right posterior oblique view. Lesion is demonstrated (arrow).

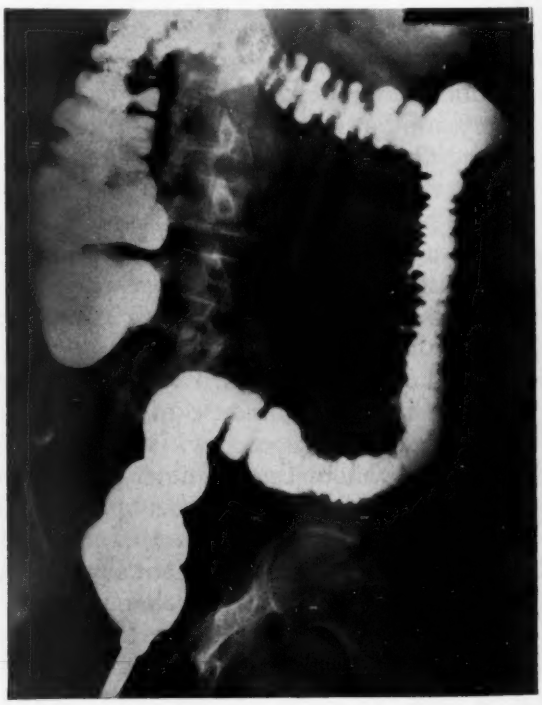


FIG. 5. Case II. Lesion not seen on filled colon.

Lapiné view, by projecting the lesion in profile, shows it clearly.

Here, again, the special view allowed the roentgenographic demonstration of a lesion in the filled colon, which could not be seen on the routine projections, although it was visualized roentgenoscopically. In this case the lesion could also be seen on the postevacuation film. However, exclusive dependence on the postevacuation film for the demonstration of lesions of the colon may be hazardous, since significant lesions may escape detection;[9] proper coating of the evacuated colon depends on various factors not under the control of the examiner.

Case III. A.S., a widow, aged fifty-four, had had dull intermittent pain in the left lower quadrant for one year and constipation for the past six months. She noted no gross blood. Two weeks before admission she had a febrile episode with intermittent shaking chills; this illness responded to penicillin. By physical examination there was a rounded 5 cm. tender and slightly movable firm mass in the lower abdomen. Rectal examination revealed no intrinsic pathology. Sigmoidoscopy to 25 cm. was negative. It was not difficult to visualize the large lesion of the pelvic sigmoid at roentgenoscopy or its proximal portion on either the anteroposterior, oblique or lateral projections (Fig. 8, 9 and 10). Its entire extent was not demonstrated on any of these views because of foreshortening produced by the projections or obliteration by overlying colon. However, the angle anteroposterior and the Chassard-Lapiné projections (Fig. 11 and 12) demonstrated the lesion in its entirety; had the lesion been limited to its distal portion it is quite possible that it

Fig. 7. Case II. Chassard-Lapiné view. Lesion is seen (arrow).

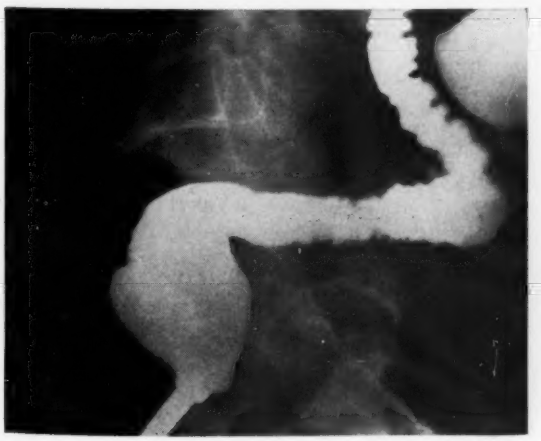


Fig. 6. Case II. Lateral view. Lesion not demonstrated.

Fig. 8. Case III. Anteroposterior film of filled colon. Proximal part of lesion seen (arrows).

Fig. 9. Case III. Left posterior oblique view. Only part of the neoplasm is clearly seen.

would have shown only in the special views and been missed on the routine projections.

In addition to these instances in which the special views demonstrated sigmoid lesions to best advantage, there have been several cases in which neoplasm of the sigmoid had been suspected at barium enema examination elsewhere. At our roentgenoscopy, visualization of the sigmoid was unsatisfactory due to overlap or marked obesity of the patient; routine projections, because of the failure to uncoil the sigmoid, could not be relied upon. Special views, by showing a normal-appearing, uncoiled sigmoid, gave assurances of the absence of a lesion.

A study was also made of several normal colons in an effort to determine what advantage the different positions may have in examining various types of sigmoid loops.

Case IV. *Angle Anterposterior Projection.* In obtaining the angle anteroposterior view, filling is accomplished to the mid-descending colon and an anteroposterior film is obtained with the central beam being directed cephalad at an angle of 35 to 40 degrees. In this way, the anteriorly placed overlying sigmoid coils are projected above the posteriorly placed rectosigmoid. Hence in the routine anteroposterior view (Fig. 13), the upper rectum and proximal pelvic sigmoid are not well visualized; whereas, in the angled view (Fig. 14), the coils are spread nicely.

Case V. *Angled Oblique Projection.* Frequently the oblique view (usually the left posterior oblique) will separate the coils of the sigmoid adequately. However, on occasions, angling the central beam 35 to 40 degrees cephalad with the patient in a posterior oblique position will improve the view. The oblique film (Fig. 15) shows the sigmoid loop fairly well, although there is still some overlapping; the angled oblique view (Fig. 16) separates the overlapping loops satisfactorily.

Case VI. *Chassard-Lapiné View.* By allowing projection of the central beam perpendicular

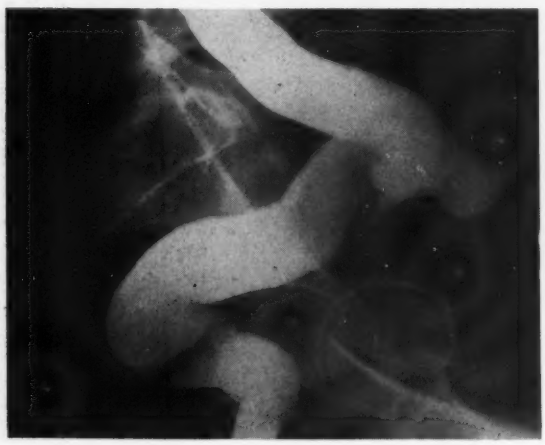


Fig. 10. Case III. Lateral view. Neoplasm incompletely seen.

Fig. 11. Case III. Angle anteroposterior view. Entire extent of the lesion demonstrated.

Fig. 12. Case III. Chassard-Lapiné projection. Entire extent of the neoplasm demonstrated.

to the pelvic outlet, the Chassard-Lapiné view is very useful for separating coils of sigmoid which are superimposed in the anteroposterior plane. Thus in the anteroposterior projection of the filled colon of this patient (Fig. 17), the sigmoid is hopelessly covered by its own meanderings as well as by the low-lying transverse colon. The lateral view (Fig. 18) is of no help. The Chassard-Lapiné projection (Fig. 19) demonstrates the sigmoid clearly; as the patient leans forward in the performance of this view, the transverse colon is moved into a

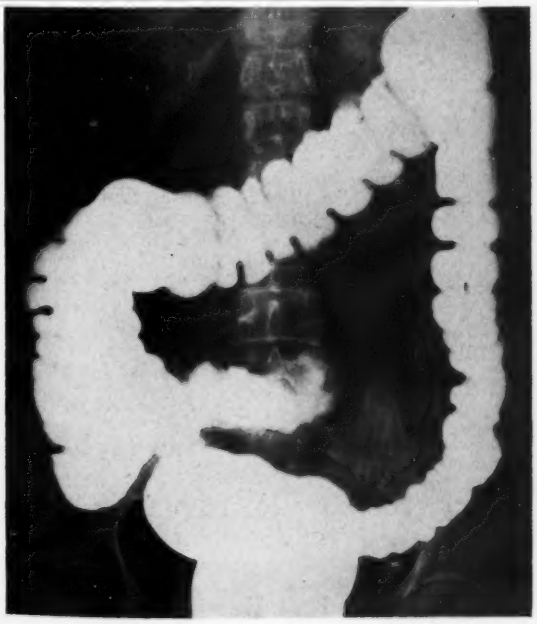


Fig. 13. Case IV. Anteroposterior film of filled colon. Sigmoid not well demonstrated due to overlapping.

Fig. 14. Case IV. Angled anteroposterior projection. Sigmoid coils are spread.

Fig. 15. Case V. Left posterior oblique view.

Fig. 16. Case v. Angled left posterior oblique view.

plane anterior to the sigmoid loop and is thus thrown free of the loop.

Case vii. In selected cases, filling of the urinary bladder will aid in visualization of the sigmoid by elevating several of the coils and thus separating them. This patient was asked

Fig. 17. Case vi. Anteroposterior film of filled colon. Sigmoid is obscured by its own loops as well as the low-lying transverse colon.

Fig. 18. Case vi. Lateral film of filled colon. Sigmoid poorly visualized.

to drink four glassfuls of water during a three hour period preceding the examination and to refrain from urination. Figure 20 shows the barium-filled sigmoid under these conditions;

Fig. 19. Case vi. Filled Chassard-Lapiné view. The sigmoid coils are spread and the low-lying transverse colon is projected out of the way.

Fig. 20. Case vii. Sigmoid elevated by the distended urinary bladder.

Fig. 21. Case vii. Urinary bladder emptied. Sigmoid is coiled in the true pelvis and not well seen.

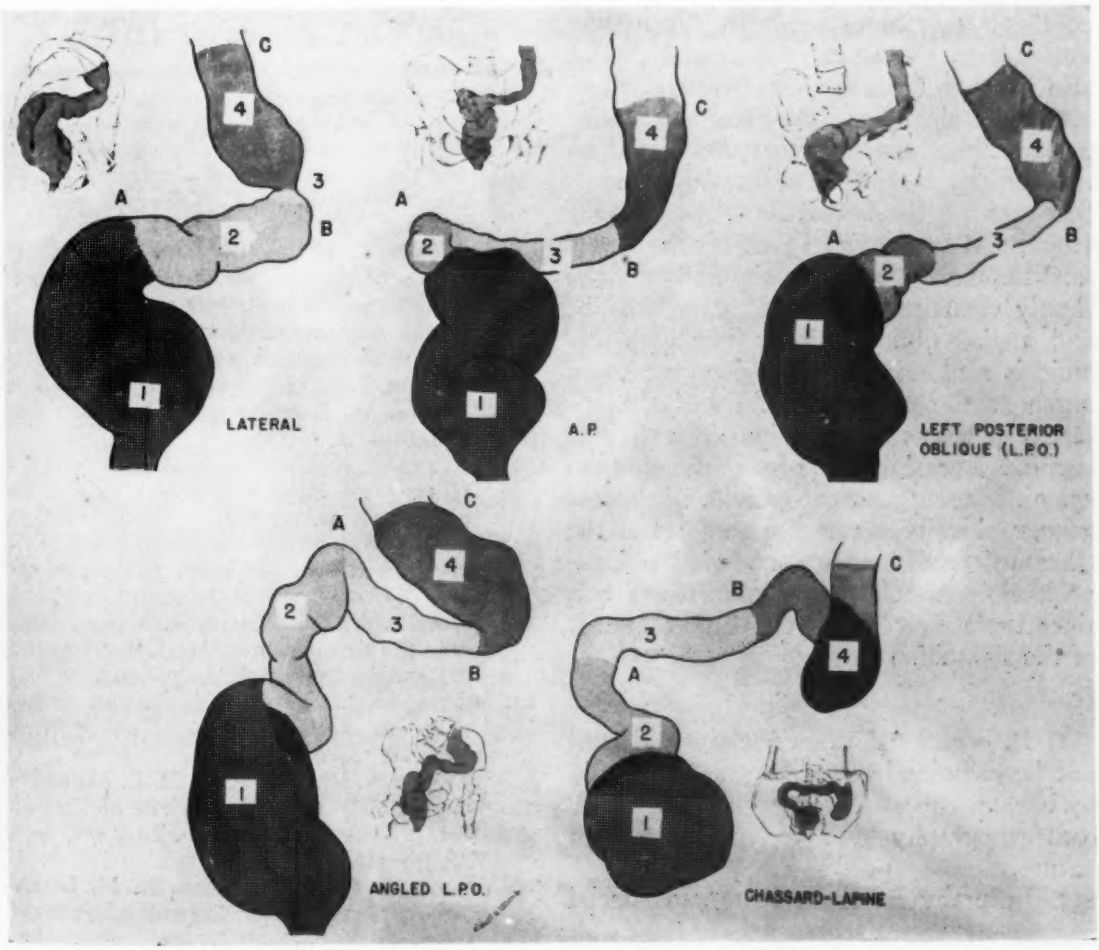


Fig. 22. Simplified drawings of the various projections of the sigmoid.

the filled bladder elevated the coiled sigmoid and in so doing produced significant unfolding. Following evacuation of the colon and voiding, the sigmoid was filled again with barium (Fig. 21); the sigmoid now is not demonstrated satisfactorily.

Figure 22 is a series of simplified drawings made of the various projections of the sigmoid of one of our patients. It represents one type of a coiled sigmoid. No single view demonstrates all parts of the rectum, rectosigmoid and sigmoid completely, although all the projections together do. An analysis of these drawings indicates which projections are best suited for the various parts of the sigmoid in this type of colon. For purposes of discussion, rough division has been made: (*1*) rectum, (*2*) rectosigmoid, (*3*) pelvic sigmoid, and (*4*) iliac sigmoid. *A*, *B* and *C* represent corresponding points on the various drawings. The rectum is best seen on the lateral view, although also fairly well on the anteroposterior and oblique projections; the Chassard-Lapiné projection is unsatisfactory for visualization of the rectum. The rectosigmoid is best seen on the lateral or angled oblique views, and its proximal part on the Chassard-Lapiné. The pelvic sigmoid is most clearly visualized on the Chassard-Lapiné and angled oblique views. The iliac sigmoid is well seen on all projections. Inasmuch as the pelvic sigmoid and the adjacent portions of rectosigmoid and iliac sigmoid occasionally prove difficult to examine roentgenoscopically and roentgenographically, more frequent use of the Chassard-Lapiné and the angled oblique projections should prove of distinct aid, since these views are optimal for this area of the sigmoid.

SUMMARY

1. In occasional cases the sigmoid cannot be examined completely satisfactorily by barium enema at roentgenoscopy or by roentgenography due to its multicoiled nature.

2. In many of these instances special roentgenographic techniques will be of aid.

3. Several examples of these special views have been presented.

4. The value of the angled and the Chassard-Lapiné projections is emphasized.

Alice Ettinger, M.D.
30 Bennet St.
Boston 11, Massachusetts

REFERENCES

1. Barden, R. P. Editorial. Art of roentgenoscopy in general and its use in study of colon in particular. Am. J. Roentgenol. & Rad. Therapy, 1943, *50*, 538–541.
2. Bell, J. C., and Douglas, J. B. Roentgen-ray diagnosis of malignant and potentially malignant lesions of colon and rectum. *Radiology*, 1948, *51*, 297–304.
3. Billing, L. Zur Technik der Kontrastuntersuchung des Colon sigmoideum. *Acta radiol.*, 1944, *25*, 418–422.
4. Bockus, H. L., and others. Gastro-Enterology. W. B. Saunders Company, Philadelphia, 1944, Vol. II, p. 765.
5. Boehme, E. J., and Hanson, P. J. Carcinoma of colon and rectum; site of growth of 1,457 lesions. *S. Clin. North America*, 1946, *26*, 551–552.
6. Chassard and Lapiné. Étude radiographique de l'arcade pubienne chez la femme enceinte; une nouvelle méthode d'appréciation du diamètre bi-ischiatique. *J. de radiol. et d'électrol.*, 1923, *7*, 113–124.
7. Fletcher, G. H. Improved method of visualization of sigmoid. Am. J. Roentgenol. & Rad. Therapy, 1948, *59*, 750–752.
8. Gray, H. Anatomy of the Human Body. Lea & Febiger, Philadelphia, 1942, pp. 1201–1202.
9. Hamilton, J. B. Use of tannic acid in barium enemas. Am. J. Roentgenol. & Rad. Therapy, 1946, *56*, 101–103.
10. Levene, G., and Bragg, E. A., Jr. Mobility of rectosigmoid; new diagnostic sign. *Radiology*, 1950, *54*, 717–725.
11. Raap, G. Position of value in studying pelvis and its contents. *South. M. J.*, 1951, *44*, 95–99.
12. Robins, S. A., and Altman, W. S. Significance of lateral view of rectum. Am. J. Roentgenol. & Rad. Therapy, 1938, *40*, 598–605.
13. Smedal, M. I. Use of double contrast enemas in lesions of colon. *S. Clin. North America*, 1946, *26*, 594–602.
14. Stewart, W. H., and Illick, H. E. Method of more clearly visualizing lesions of sigmoid. Am. J. Roentgenol. & Rad. Therapy, 1932, *28*, 379–384.
15. Wissing, E. G., and Lowman, R. M. Lateral view in roentgenologic diagnosis of lesions of colon. *New England J. Med.*, 1943, *229*, 207–210.

Vol. 72, No. 2

PRIMARY LYMPHOSARCOMA OF THE STOMACH

By CORNELIUS COLANGELO, M.D.
Radiologist, Alexian Brothers Hospital
CHICAGO, ILLINOIS

PRIMARY lymphosarcoma of the stomach is uncommon. The symptoms and findings are not diagnostic and may resemble those of gastric carcinoma, gastritis and peptic ulcer. It may be impossible to differentiate between these conditions by clinical means, including roentgen examination and gastroscopy.

The following report is presented to illustrate these points:

The patient was a white male, aged fifty-nine, whose presenting complaint was epigastric burning before and after meals, relieved by milk, and of four months' duration. There were also anorexia, weakness, and a 20 pound weight loss.

Physical examination did not show peripheral adenopathy, an epigastric mass nor any other significant abnormality, and the state of nutrition was good.

The blood counts, hemoglobin level and blood sugar were normal and the blood serology was negative. Urinalysis revealed albuminuria, but was otherwise normal.

Roentgen studies showed normal gallbladder function and a normal heart and lungs. Roentgen examination of the stomach in June, 1951, demonstrated coarse rugae and a tubular pylorus, but the stomach changed contours fully with peristalsis and exhibited normal pliability and mobility (Fig. 1). There was a 20 per cent gastric residue at the end of five hours.

The significance of the coarse rugae and the five hour gastric residue was not known, but it was recommended that the patient be studied clinically to rule out gastric cancer, and gastroscopy and gastric analysis were advised.

Analysis of stomach contents was done in July, 1951, and did reveal free hydrochloric acid but no blood, lactic acid or Boas-Oppler bacilli.

The patient continued to experience epigastric burning brought on by hunger, often associated with regurgitation, and frequently causing him to awaken at 2 A.M. Banthine, an anticholinergic agent, gave marked relief but milk was less effective in controlling the symptoms. A bland diet was also observed as part of the ulcer regimen.

In October, 1951, he was referred for roentgen examination and stated that for the preceding two months there had been no weight loss. The stomach then showed findings essentially as noted four months earlier (Fig. 2), except that there was now a smaller five hour gastric residue of only 10 per cent. Antral gastritis and cancer of the stomach were considered diagnostic possibilities, but neither condition could be identified unequivocally from the roentgen evidence. Furthermore, the patient's symptoms were those of peptic ulcer.

Gastroscopy was done elsewhere in November, 1951, and an acute, very small (3 mm.), superficial ulcer on the lesser curvature of the antrum and a moderate hypertrophic gastritis were reported. The mucosa appeared thickened and velvety. Gastric contents aspirated at the time of gastroscopy did not contain free hydrochloric acid.

Encouraged by this report, the patient chose to continue medical treatment as he did not desire surgery. His condition remained unaltered and he returned in February, 1952, for reexamination. The stomach now showed marked and increased coarseness of the pyloric rugae which were also irregular at this examination. The stomach was not as pliable as it had been, and while its contours changed with peristalsis, they did not change as fully or as readily as before (Fig. 3).

Surgery was again urged but was deferred by the patient for several months. Physical examination before surgery was again normal and did not reveal peripheral adenopathy or an epigastric mass. The blood count was normal. There had been no further weight loss.

Surgical exploration on June 26, 1952, revealed a lesion resembling carcinoma so closely that the operative diagnosis was: "A large prepyloric carcinoma with metastasis along the left gastric artery and into the omental glands." Subtotal gastric resection with gastrojejunal anastomosis was performed.

The pathologist, too, made a gross diagnosis of carcinoma and described a 6 cm. thickening

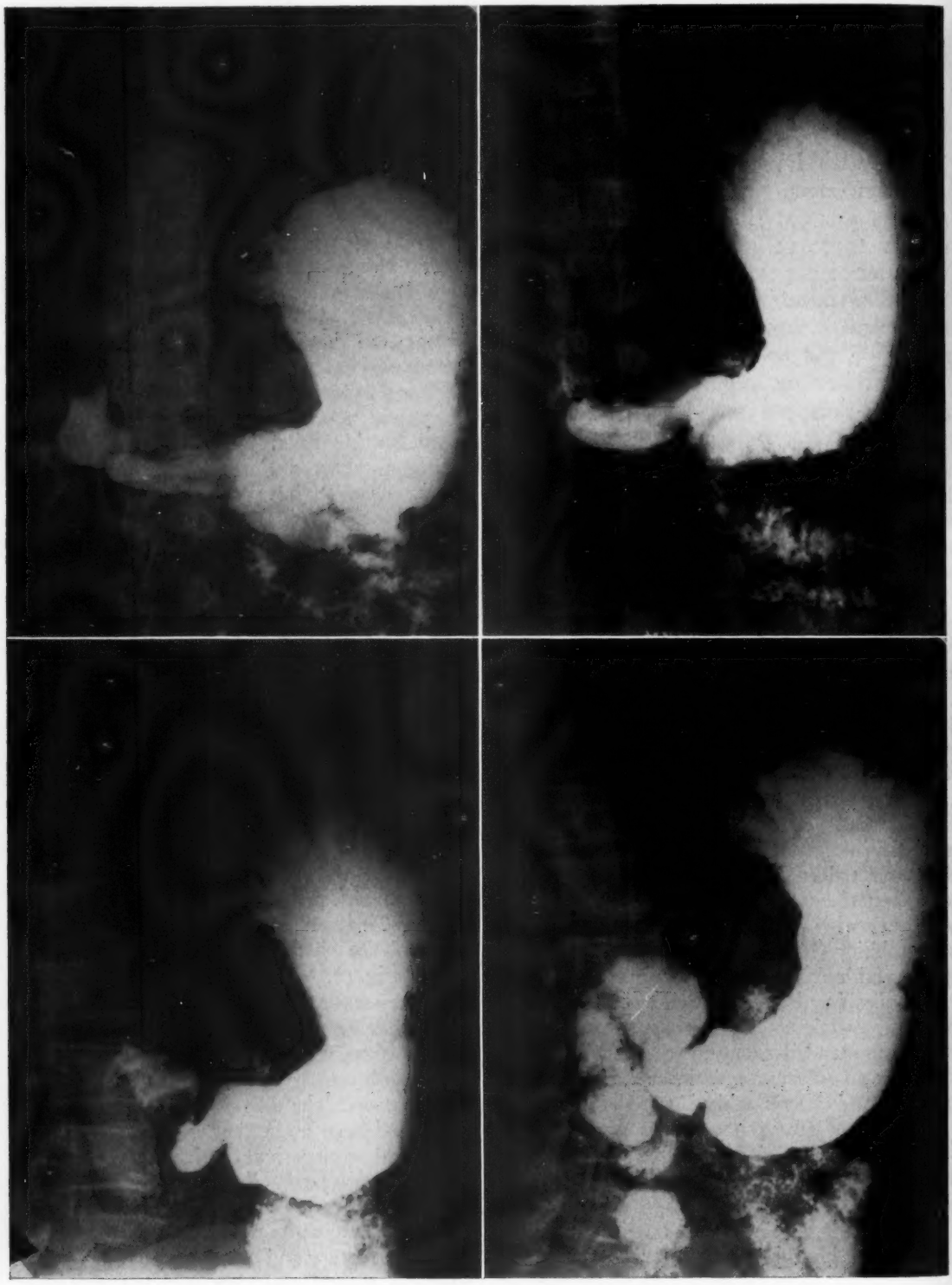


Fig. 1. Examination of June, 1951. The upper films show the coarse rugae of the pyloric area. The lower films show the stomach changing contours with peristalsis.

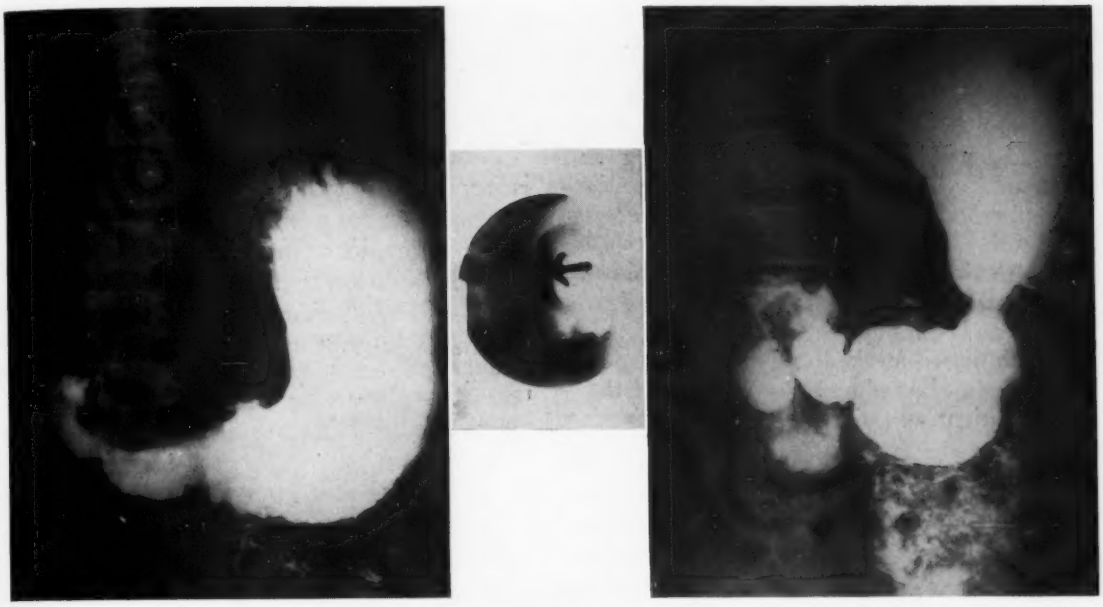


Fig. 2. Examination of October, 1951. The small film shows a coarse pyloric ruga (arrow).

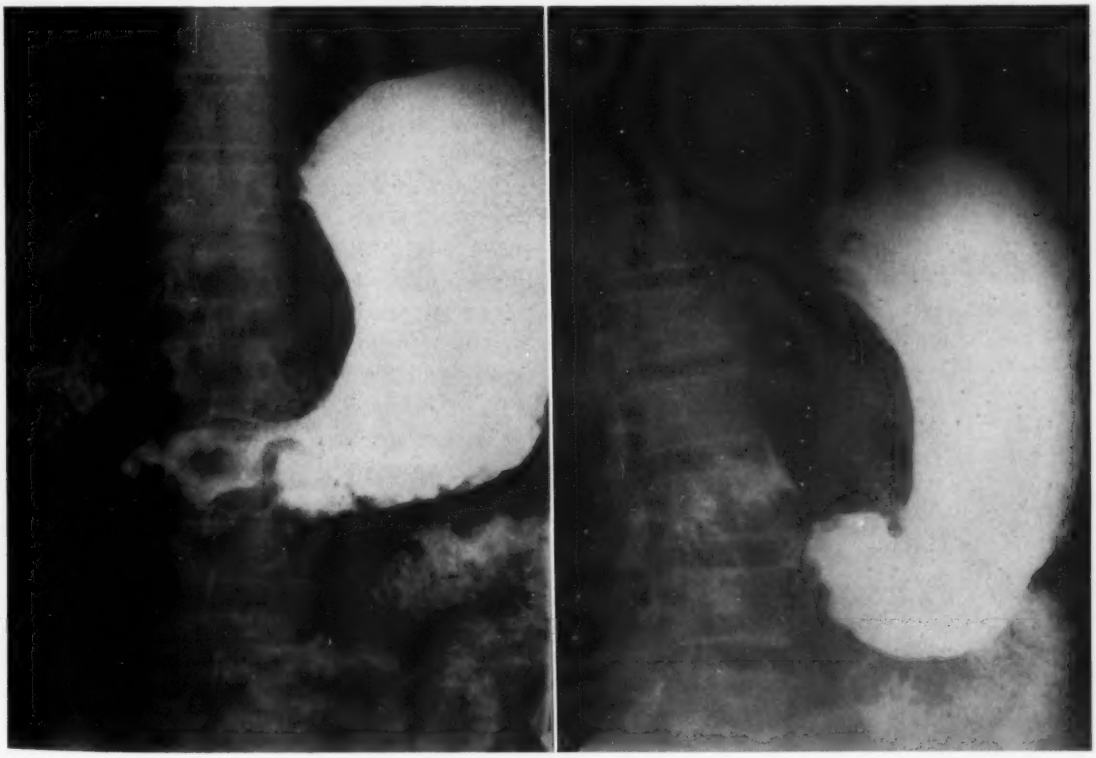


Fig. 3. Examination of February, 1952. The rugae are coarse and irregular but there is still change in the contour of the pylorus with peristalsis.

of the wall of the distal end of the stomach, especially about the greater curvature. The rugae were tortuous and thickened. There was a superficial 1 by 2 cm. ulcer on the greater curvature within the thickened area of the stomach, and the mucosa surrounding and proximal to this ulcer was nodular. A questionable superficial ulcer was described on the lesser curvature.

The sections showed a large cell lymphosarcoma extensively invading the mucosa and submucosa and also involving the muscular coats, although not so markedly. One of the regional lymph nodes showed a similar tumor growth.

The patient was discharged after recovering from the surgery and is to return for roentgen therapy to the abdomen.

SUMMARY

A case of primary gastric lymphosarcoma is reported which presented features resembling antral gastritis, gastric carcinoma and peptic ulcer. In this patient, the distinction between lymphosarcoma and carcinoma of the stomach was not possible by clinical or laboratory means except biopsy.

1200 Belden Ave.
Chicago 14, Illinois

Vol. 72, No. 2

CORRELATION OF THE CLINICAL, PATHOLOGICAL AND ROENTGENOLOGICAL FINDINGS IN DIVERTICULITIS*

By ALEXANDER GOULARD, Jr., M.D., *and* AUBREY O. HAMPTON, M.D.
WASHINGTON, D. C.

ALTHOUGH acute and chronic diverticulitis is a common and well known entity, the gross tissue and roentgenologic pathology have not previously been correlated with the clinical findings. Primarily we are interested in differentiating between acute and chronic diverticulitis on the basis of roentgen findings.

PATHOLOGY

The pathologic findings are based on fifteen surgically removed portions of the sigmoid colon and operative reports of 9 patients having previous barium studies. The gross pathologic result of a single or repeated episodes of inflammation with diverticula is a characteristic distortion of the bowel. The bowel is shortened as a result of fixation of inflamed diverticula in the wall or mesentery. With subsequent fibrosis, the bowel wall is thrown into numerous folds, bunched closely together. This accordion-like approximation of the folds is most marked on the mesenteric side, the area where diverticula are most prone to occur, although they are also found on the antimesenteric side. The physiologic result is limited contraction and expansion, particularly in a longitudinal direction. The changes are permanent, are the result of chronic disease, and do not necessarily indicate any persistent acute inflammation (Fig. 1).

The individual folds may or may not be enlarged. Usually they are not, and with the few specimens having enlarged folds, none of the folds measured over 1 cm. Enlargement of the folds may be due to chronic induration without acute inflammation (Fig. 3).

The interfold spaces (haustra), if sufficiently narrow, when filled with barium present the so-called "saw tooth deformity" consisting of sharply pointed spikes of barium. This deformity has previously been interpreted as evidence of acute inflammation[1,5] or a prediverticular stage of diverticulosis,[6] but which in reality is neither. The true "saw tooth deformity" is a permanent *result* of inflammation and fibrosis. It can be determined accurately only with maximum distention, as the folds normally approximate one another when the bowel is contracted. Occasionally the partially filled neck of a diverticulum will simulate a "saw tooth," but these necks are blunted where the barium is beginning to spill into the sac of the diverticulum, and distinctly different from the sharp spikes made by the interfold spaces of the shortened colon (Fig. 2 and 3).

One of the most important findings in the gross specimens of diverticulitis, no matter what the stage of inflammation, is the intact mucous membrane and muscle, which is necessary to produce a normal mucosal pattern. This plus the absence of ulceration or an elevated intraluminal margin or sessile mass must be utilized in the differentiation from carcinoma, particularly in the 15 per cent of patients with carcinoma and associated diverticulosis or diverticulitis[1] (Fig. 3). In the absence of obstruction to the flow of barium, we believe that these two lesions can and must be differentiated by the roentgenologist since often there is no other means short of resection. In one patient with obstruction to the flow of barium (without proximal distention), differentiation of diverticulitis and carcinoma could not be made roentgenologically nor by subsequent sur-

* From the Radiological Clinics of Drs. Groover, Christie, and Merritt, Washington, D. C.

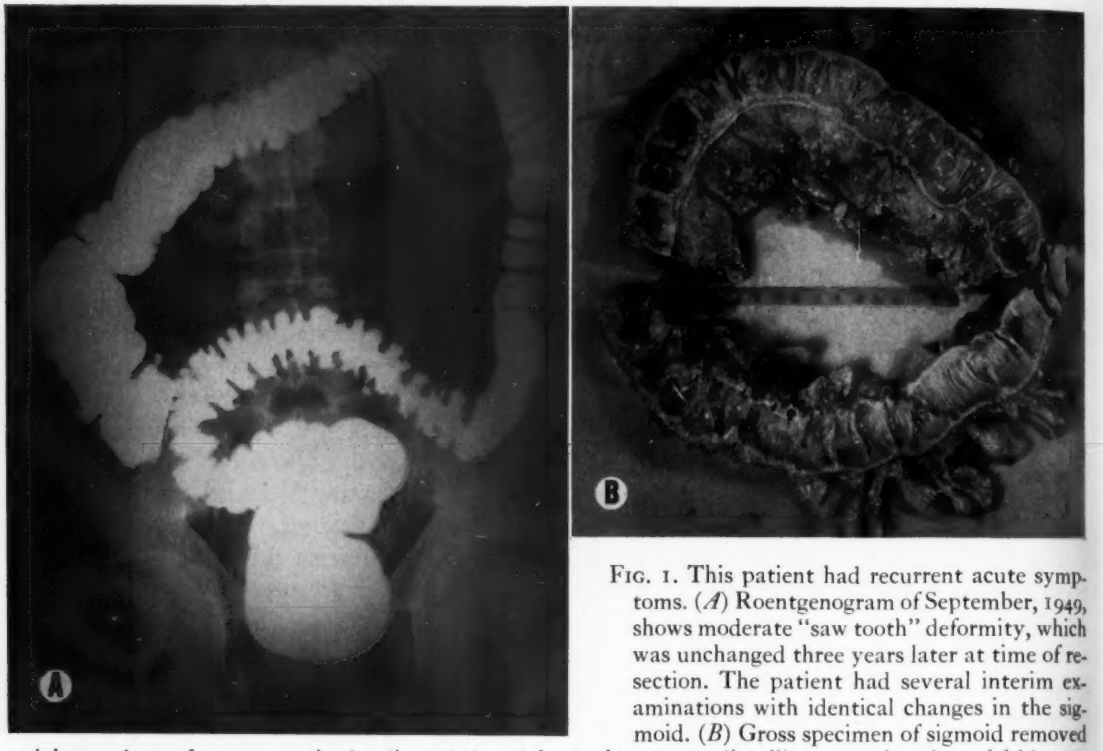


FIG. 1. This patient had recurrent acute symptoms. (*A*) Roentgenogram of September, 1949, shows moderate "saw tooth" deformity, which was unchanged three years later at time of resection. The patient had several interim examinations with identical changes in the sigmoid. (*B*) Gross specimen of sigmoid removed eighteen days after acute episode, distended and fixed, shows accordion-like approximation of folds particularly in the area of the diverticula in the appendices epiploicae (arrows). Folds are not enlarged. No acute inflammation microscopically in sections through areas of greatest approximation.

gical exploration. Therefore, it seems logical to withhold exploration until the acute inflammatory signs have subsided and satisfactory barium examination can be done.

CLINICAL FINDINGS

In the past twenty-two months, 2,100 patients were examined by barium enema. Of these, 385 had diverticula and 158 had a roentgen diagnosis of acute diverticulitis. Only 70 of these patients were admitted to the hospital, and hence have available clinical records. The roentgen diagnosis was made without or with only partial knowledge of the clinical diagnosis and on the basis of the long accepted combination of "saw tooth" deformity plus diverticula; therefore, acute diverticulitis. Telling has estimated that approximately 60 per cent of patients with diverticulosis develop diverticulitis.[6] Bockus[1] states that only 22–27 per cent of patients with diverticulosis develop diverticulitis. In an effort to clarify for ourselves this discrepancy, a small group of 30 patients diagnosed as having diverticulosis, clinically and by roentgen ray, with good distention of the involved bowel, were reviewed. Of these, 17 showed evidence of fibrotic shortening, particularly where the diverticula were multiple.

On review of the clinical records of the 70 patients, only 35 were considered to have sufficient evidence (combining the history, various types of examinations, and course of the disease) to justify a diagnosis of acute diverticulitis. The usual symptoms and signs were lower abdominal pain, fever, leukocytosis, change in bowel habits, and localized tenderness. Approximately one-third of the patients had a definite history of previous attacks of left lower quadrant pain. The average temperature, when acute, was 99–101° F., and the average duration of acute symptoms was four

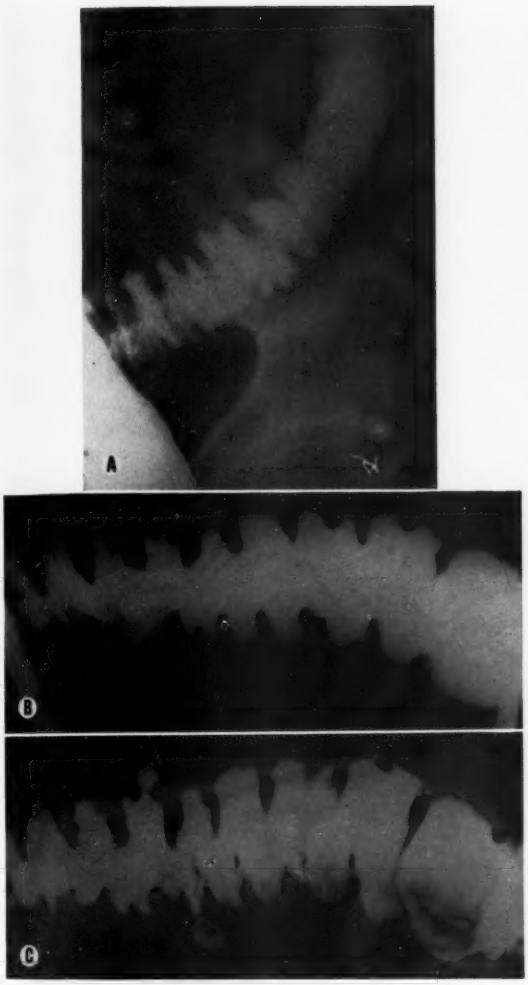


Fig. 2. (*A*) Roentgenogram taken on July 28, 1950, shows shortened serrated sigmoid. Patient had recurrent symptoms, and deformity was unchanged over a one year period even though the patient was examined both while acute and asymptomatic. Diverticula never completely filled on any examination, including oral method. The neck of one diverticulum seen as blunt, inverted, comma-shaped projection. (*B*) Serrations demonstrated on gross specimen produced by narrowed spaces between folds. (*C*) Diverticula easily filled on gross specimen, present on mesenteric and antimesenteric side. Microscopic examination showed only minimal fibrosis.

days, although moderate left lower quadrant tenderness persisted in some patients for periods up to two weeks. The most correlative symptom was dysuria, which was present in all cases of demonstrable abscesses over 6 cm. in size and not present without a demonstrable abscess. Telling estimates that a mass may be palpated in the left lower quadrant in 30 per cent of cases. In this series it was palpated in 9 of the 35 cases, or 26 per cent. The mass is usually described as being sausage shaped. That a palpable sigmoid may be misinterpreted as a mass is demonstrated by the fact that in this group of the 9 masses palpated, 4 patients had abscesses under 3 cm. in diameter, and in 1 case a mass palpated twenty-four hours prior to surgery was not found at the time of resection.

ROENTGENOLOGICAL FINDINGS

Case[2] has stated that the diagnosis of acute diverticulitis is largely clinical. The prime effort made here is to emphasize those roentgen findings which will increase the accuracy of the determination of the stage of the disease. The length of involvement, deformity of the bowel, localization and size of abscesses, complications, and the evaluation of acuteness or chronicity should be the aims of the roentgenologist's examination. Obviously, from the tabulated figures (Table 1), a large discrepancy existed between the clinical and roentgenographic diagnoses of acute diverticulitis.

It should be stated that we believe, as others, that there are no contraindications to the use of barium enema no matter what the stage of the disease.[3] Of the 35 patients examined here with acute disease there were no complications except for elevation of temperature. It is significant that the only temperature elevations occurred in patients with abscess cavities broken into and filled with barium. With an obvious subsequent drainage tract into the bowel, these temperature elevations were transient, usually twenty-four hours.

Since only half of the patients with a diagnosis of acute diverticulitis on roentgen examination actually had clinically acute diverticulitis, it is advisable to review the roentgenographic criteria. The usual criteria for the diagnosis of acute diverticu-

TABLE I

Number of patients examined by barium enema	2,100
Number of patients with diverticula	385 (18.3%)
Patients with roentgen diagnosis of acute or subacute diverticulitis	158
Number of cases diagnosed acute diverticulitis by roentgen ray with available clinical records	70
Number of cases so diagnosed with clinical evidence of acute or subacute diverticulitis	35
Average length of acute symptoms	4 days
Serrated ("saw tooth") appearance of bowel	43
a. With acute symptoms	20
b. Asymptomatic	23
c. Repeated examination at over three month interval and with no change of deformity (six asymptomatic interims)	10
d. Acute clinically without this deformity	15 (43%)
e. Presence of an abscess without this deformity	11 (26%)
Cases with *reported* spasm	45
a. With clinical evidence of diverticulitis	20
b. Without clinical evidence of diverticulitis	25
c. Clinically acute without spasm	15 (43%)
Reviewed cases with persistent spasm during any one examination (all were acute clinically)	13

litis has been (1) the demonstration of diverticula, (2) the serrated or "saw tooth" deformity, (3) determination of spasm, (4) localized tenderness, and (5) presence of abscess.

(1) *Diverticula.* As has been stated by others,[1,2] diverticula may not be demonstrated in the presence of diverticulitis. The incidence of failure of diverticula to fill is not known, but of this group of 35 cases with acute disease, diverticula were not filled on the initial examination of 6 patients, 2 of whom had abscesses demonstrated by roentgen ray and 2 others had surgically demonstrated abscesses. In 1 of these a barium enema examination prior to surgery was entirely normal. Of the 6 patients, 3 had diverticula demonstrated on later barium examination. Diverticula were never satisfactorily filled in 1 patient in spite of numerous examinations, including the oral barium method, both while acute and during remissions. On one occasion, what was thought to be the neck of a diverticulum was demonstrated. On the resected specimen, several diverticula were easily filled with barium (Fig. 2). Delayed films, twenty-four or forty-eight hours after barium enema or the use of 1 to 3 ounces of oral barium will frequently demonstrate the previously unfilled diverticula (Fig. 6). This portion of the examination may be quite important, as tenderness and the presence of diverticula may be the only manifestations of acute diverticulitis, while tenderness alone, particularly in the female, is insufficient evidence to establish a diagnosis.

(2) *"Saw Tooth" Deformity.* Serrations of the distended colon represent narrow spaces between approximated folds (Fig. 2*B*). The folds may be relatively closely grouped without producing serrations (Fig. 7*B*). The basic pathology is fibrotic shortening of the bowel and thickening of the folds. Serrations are permanent and indicative of previous inflammation, as is illustrated by the fact that 10 patients had no change in the deformity at intervals of three months to three years, 6 with asymptomatic interims. There is no correlation between the deformity and a single attack of acute diverticulitis. From Table 1 it is seen that only 20 of 43 patients with a visible "saw tooth" deformity had acute diverticulitis, while 23 were asymptomatic. On the other hand, 15, or 43 per cent, of those with acute diverticulitis did not have a "saw tooth" deformity.

(3) *Spasm.* It is not unusual for us to see transitory contractions of the normal colon during filling, particularly of the descending and sigmoid portions. These contractions may be related to the preparatory castor oil or to the tannic acid in the suspension. Their true nature is very difficult to evaluate during roentgenoscopy, particularly in an area narrowed and distorted

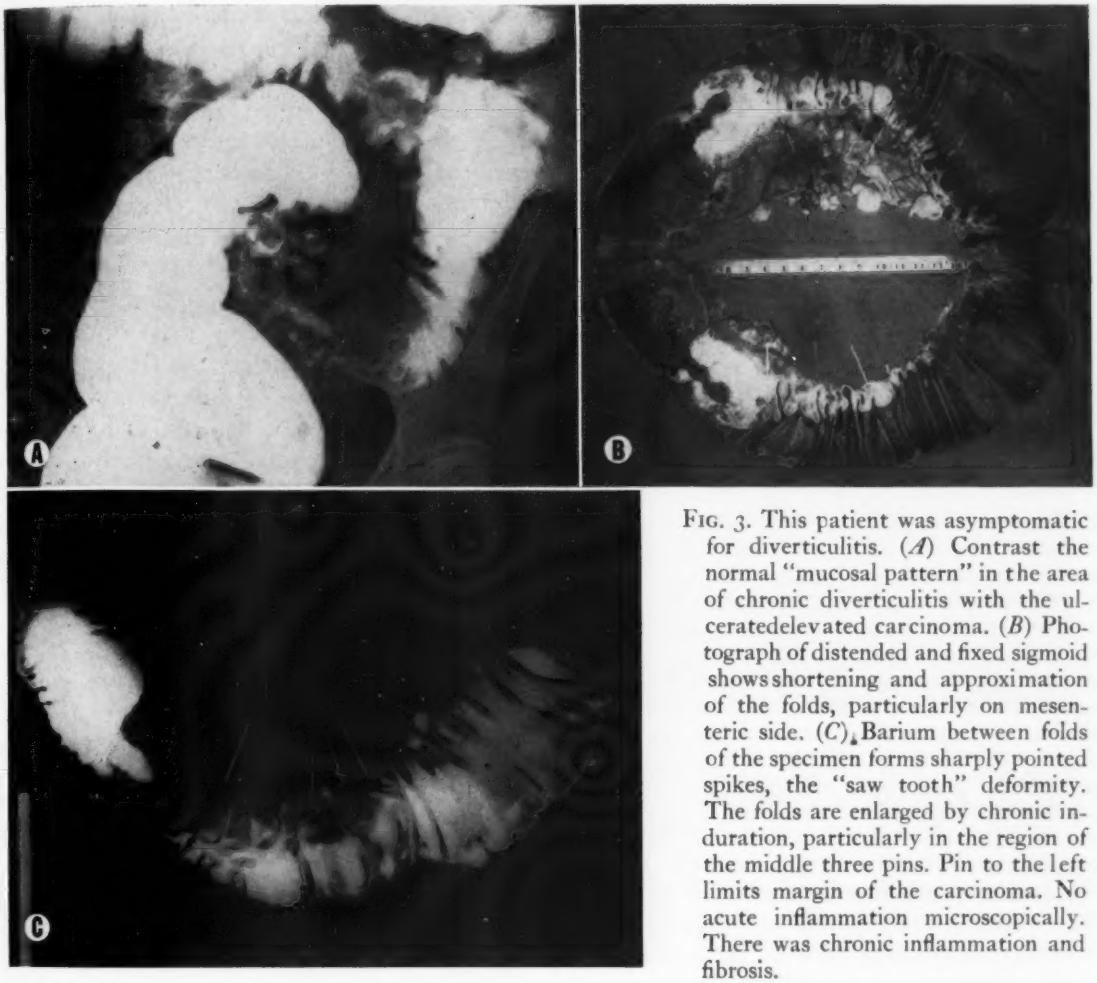


Fig. 3. This patient was asymptomatic for diverticulitis. (*A*) Contrast the normal "mucosal pattern" in the area of chronic diverticulitis with the ulceratedelevated carcinoma. (*B*) Photograph of distended and fixed sigmoid shows shortening and approximation of the folds, particularly on mesenteric side. (*C*) Barium between folds of the specimen forms sharply pointed spikes, the "saw tooth" deformity. The folds are enlarged by chronic induration, particularly in the region of the middle three pins. Pin to the left limits margin of the carcinoma. No acute inflammation microscopically. There was chronic inflammation and fibrosis.

by chronic disease. Of 45 cases with reported spasm, only 20 patients had acute diverticulitis. while the remainder were asymptomatic. Also, 15 patients with acute diverticulitis, often with demonstrable abscesses, did not have reported spasm.

In an effort to clarify pathologic spasm, we then defined it as a state of contraction which is *persistent* during any one examination. The best method of determining significant spasm of the sigmoid is with the remainder of the colon filled and the patient face down. All the numerous films of patients with known acute diverticulitis were reviewed, and of the 35 cases we could find only 13 in which the diseased area remained contracted. It should be emphasized that acute diverticulitis may be present without spasm as the roentgenoscopist failed to record it in 15 of the 35 cases and the films failed to demonstrate it in 22 of the 35 cases.

(4) *Tenderness*. What then are the reliable findings of acute diverticulitis? We believe that the roentgenologist has as many different but corroborative tools at his command as does the clinician. There are two findings which we feel are indicative of acute disease, namely, localized tenderness and the demonstration of abscesses. Tenderness was either recorded by the clinician or roentgenoscopist in all the cases of acute disease. In the presence of fibrotic shortening of the bowel, with or without diverticula, tenderness with accurate localization may be the only clue for the roentgenologist of an acute exacerbation.

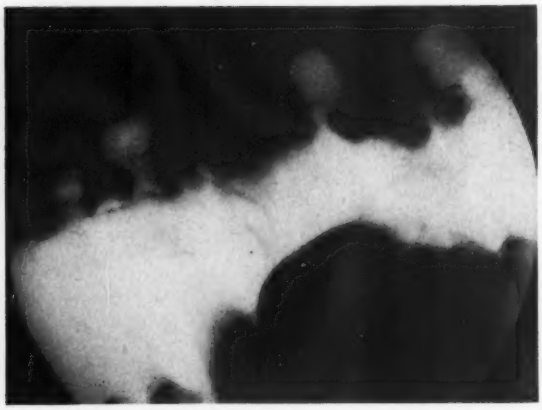


Fig. 4. This patient had acute symptoms of diverticulitis for five days. Spot roentgenogram shows a typical extramucosal inflammatory mass in profile. The surface is smooth and the margins gradually taper off at both ends. There was no spasm and the defect was not seen on the conventional posteroanterior view because of overlapping loops of sigmoid.

(5) *Abscess Formation.* It has been stated that perforation of a diverticulum with abscess formation is rare. We believe that the case is exactly the reverse, and that acute diverticulitis results from a perforated diverticulum with cellulitis and abscess formation even though the abscesses may be quite small. We have become particularly interested in the roentgenographic demonstration of these abscesses, and Table II shows the incidence in this series. It is significant that by examination of the bowel in various views, with and without pressure, perisigmoidal abscesses have been demonstrated in 21 of the 35 cases of acute diverticulitis, or 60 per cent. The majority of the abscesses demonstrated both by roentgen ray and gross specimens vary from 1.5 to 4 cm. in diameter. Roentgenographically, these abscesses may be manifested as tender extramucosal defects with an intact overlying mucosal surface and fading margins in profile (Fig. 4). They are particularly prone to be in areas of chronic disease and may remain long after subsidence of acute symptoms or local tenderness. The reason they persist is apparently failure of drainage and walling off with a gradual replacement by fibrous tissue. When demonstrated with tenderness, they are pathognomonic of acute diverticulitis. Without tenderness or other evidence of diverticulitis, it would be difficult to differentiate these abscesses from any extramucosal mass such as metastatic carcinoma or endometriosis. We have not encountered folds sufficiently large to simulate an abscess, and furthermore, an abscess may be seen to cross the boundaries of the folds at an oblique or right angle (Fig. 5). While we have not demonstrated an abscess in any patient without clinical

Table II

Presence of an abscess demonstrated roentgenographically. (All had acute or subacute symptoms.) This is 60% of those with clinically acute disease.	
a. Mass palpated clinically	9 (26%)
b. Surgically confirmed (remainder not operated upon)	6
c. Acute clinically with surgically demonstrated abscess which was not found clinically nor by roentgen ray	4
d. Method of abscess demonstration..	
1. Tender extramucosal mass	13
2. Filling the abscess with barium	8

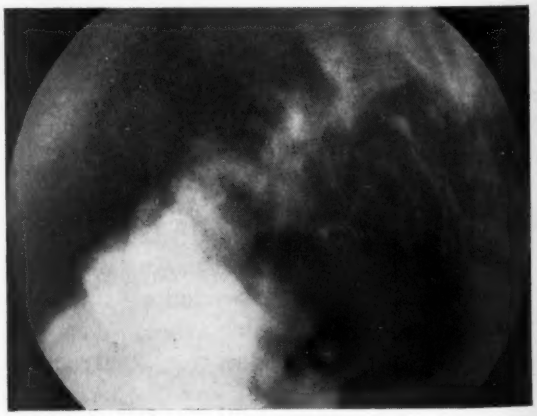


Fig. 5. At least two adjacent extramucosal masses are seen, the uppermost and largest measuring 2.5 cm. There was localized tenderness. A normal mucosal pattern is produced by the surrounding contracted colon and the margins are sharp and smooth. Note how the larger mass (upper right) displaces a fold and crosses its margin at an oblique angle. Resection ten days later demonstrated three distinct abscesses close to each other and of the same size as shown by the spot roentgenogram.

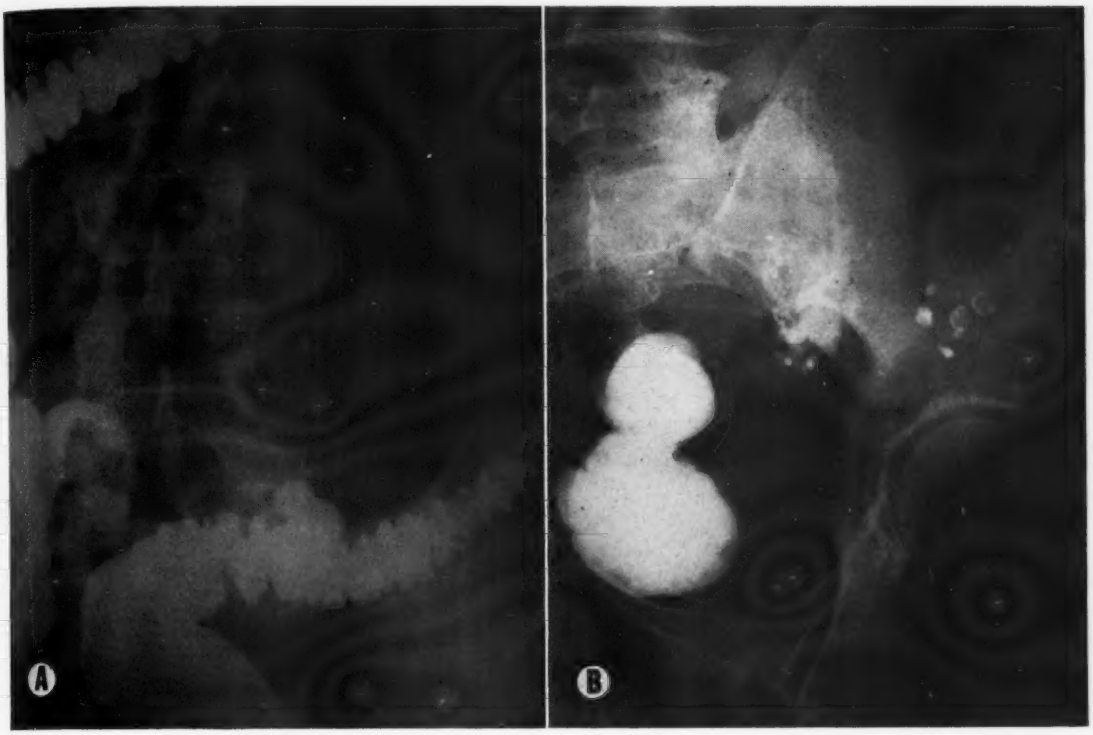


Fig. 6. This patient had acute symptoms one week prior to examination. Symptoms were subsiding. (*A*) Typical abscess cavity is filled with barium, and (*B*) retains barium twenty-four hours. Note that no diverticula are demonstrated on initial filling, but multiple diverticula are seen at twenty-four hours following evacuation.

acute diverticulitis, it is equally enlightening for us to realize that even in this group, we have not demonstrated all abscesses subsequently proved present. Four patients in this group of 70 examined immediately before surgery had acute or chronic abscesses not demonstrated on roentgenograms. Three patients had acute symptoms and 1 did not. It is undoubtedly true that the chronic abscesses with little tenderness are more apt to be overlooked by the roentgenologist simply because his attention is not as readily focused on the nontender segment of the colon as it would be on that segment with tenderness.

Another method of demonstrating these abscesses is by filling them with barium. Eight abscesses were demonstrated in this manner with no significant complications (Fig. 6). Furthermore, this filling has a definitely favorable prognosis as it indicates spontaneous drainage. None of this group required subsequent drainage, although 1 patient with a very large perisigmoidal abscess (over 12 cm.) had required drainage two weeks previously (Fig. 7). Occasionally, there will be doubt as to whether an abscess cavity is actually filled. It is well to remember that, once filled, barium will remain in the cavity and be demonstrated by plain films for at least forty-eight hours (Fig. 6).

We have been unable to predict from the clinical signs and symptoms, or from the length of illness, which patients will demonstrate abscesses or how they will be demonstrated except that there is uniformly an association of dysuria with large abscesses.

We have endeavored to show the various findings and frequency of roentgenographically demonstrable abscesses in acute diverticulitis, 60 per cent in this small series, and we hope, knowing the various manifestations of the disease, to improve our

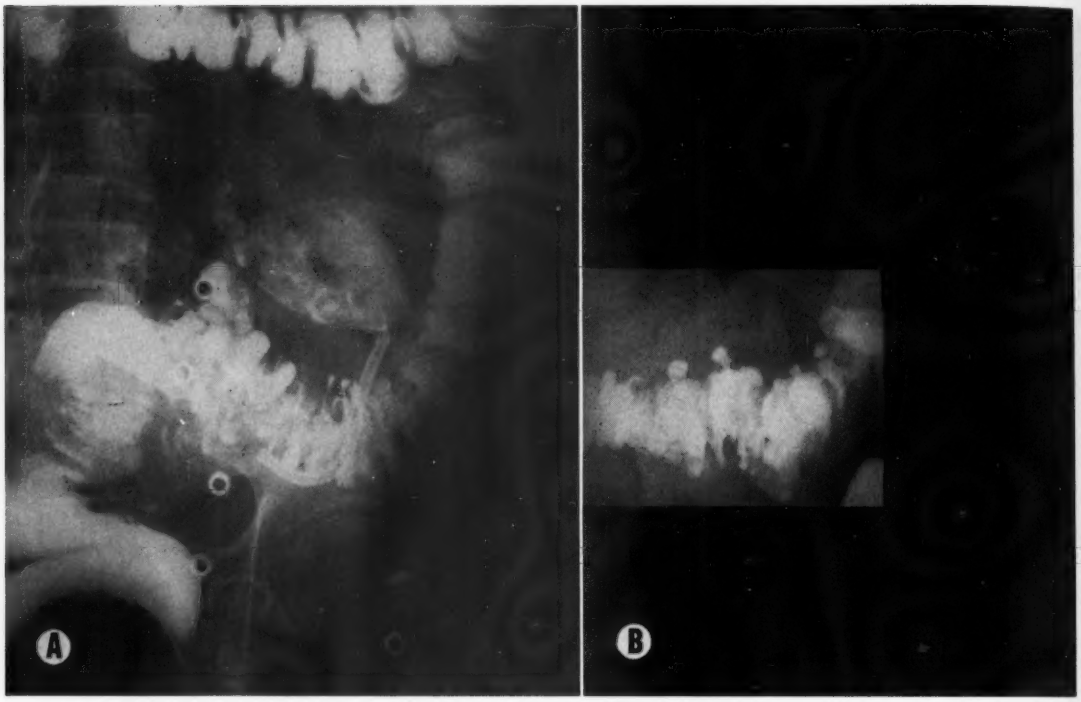


FIG. 7. (*A*) Large abscess filled with barium two weeks after emergency external drainage. Afebrile at time of examination, and remained so. No complications of the examination. (*B*) Fifty days later with good external and internal drainage and asymptomatic interim. No evidence of abscess remaining but chronic inflammatory changes of sigmoid remain with relative approximation of the folds.

percentage of significant positive findings.

CONCLUSIONS

1. There is no contraindication to the use of the barium enema examination in any stage of diverticulitis.

2. Acute diverticulitis may be present with no abnormality in the barium examination. This occurred once in a patient who underwent immediate surgical exploration following a normal barium enema examination.

3. Diverticula may not be demonstrated in the presence of acute diverticulitis. Failure to fill any diverticula on the initial examination occurred in six of the thirty-five patients.

4. The serrated ("saw tooth") appearance of the distended colon is not indicative of acute diverticulitis or a prediverticular stage of diverticulosis. Instead, these serrations are the result of chronic inflammation and fibrosis with accordion-like approximation of the folds and, as such, are permanent changes although our longest follow-ups are four years. The deformity may increase following recurrences of acute inflammation.

5. Acute diverticulitis may be present without local spasm.

6. Localized tenderness and the demonstration of abscesses, 60 per cent by roentgenoscopy and roentgenograms as opposed to 26 per cent clinically palpated, are the most reliable roentgen signs of acute diverticulitis. There were no serious complications to filling the abscesses with barium.

Alexander Goulard, Jr., M.D.
Englewood Hospital
Englewood,, New Jersey

REFERENCES

1. BOCKUS, H. L., and others. Diverticulosis and diverticulitis. In: Gastro-Enterology. W. B. Saunders Co., Philadelphia, 1944, Vol. II, Chap. LXV.

2. Case, J. T. Roentgen study of colonic diverticula. Am. J. Roentgenol. & Rad. Therapy, 1929, *21*, 207–219.
3. Fallis, L. S., and Marshall, M. R. Acute diverticulitis of large bowel. *Am. J. Surg.*, 1950, *80*, 198–203.
4. George, A. W., and Leonard, R. D. Use of x-ray in study of multiple diverticulitis of colon. *Med. Clin. North America*, 1919, *2*, 1503.
5. Golden, R. Diverticulosis, diverticulitis and carcinoma of colon; roentgenological discussion. *New England J. Med.*, 1934, *211*, 614–623.
6. Henderson, N. P. Diverticulitis and diverticulosis. *Brit. J. Radiol.*, 1944, *17*, 197–203.
7. Schatzki, R. Roentgenologic differential diagnosis between cancer and diverticulitis of colon. *Radiology*, 1940, *34*, 651–662.
8. Schatzki, R., and Hawes, L. E. Roentgenological appearance of extramucosal tumors of esophagus. Am. J. Roentgenol. & Rad. Therapy, 1942, *48*, 1–15.
9. Wigh, R., and Swenson, P. C. Roentgenologic aspects of diverticulitis and its complications. *Am. J. Surg.*, 1951, *82*, 587–596.

HERNIATION THROUGH THE FORAMEN OF WINSLOW

By ELMER G. ST. JOHN, M.D.

From the Department of Radiology, Binghamton City Hospital

BINGHAMTON, NEW YORK

RADIOLOGISTS are often consulted during acute abdominal emergencies. Common examples are to ascertain the presence of a renal calculus, whether an intestinal obstruction exists or to determine the possibility of perforation of a hollow viscus. An uncommon form of acute mechanical intestinal obstruction not often thought of is herniation through the foramen of Winslow.

LITERATURE

Blandin, in 1834 (Haxton[10]), described the first case of herniation through the foramen of Winslow. Since then more than 70 cases have been reported. A significant proportion of these ruptured through the lesser omentum also. The youngest patient was fifteen months of age and the oldest was seventy-seven years. No sex preponderance is evident.

Ullman[23] and Dewis and Miller[4] wrote comprehensive reports on the subject. Edwards and Stewart[5] reported the fifth case of herniation through the foramen of Winslow emerging through the gastrohepatic omentum. This patient died during surgery. Lying under the liver were many strangulated loops of small intestine which had passed through the foramen of Winslow and then re-entered the general abdominal cavity through an opening in the lesser omentum. The site of strangulation was not at the foramen of Winslow but at the opening in the lesser omentum. Six feet of ileum was involved up to the terminal 12 inches. The jejunum and duodenum were distended and congested. The stomach was ballooned and contained much undigested food and fluid. The mesentery was unduly long. The foramen of Winslow was dilated, admitting two fingers. No rounded anterior margin was present but there was a dense band of fibrous tissue extending between the gallbladder and the first part of the duodenum measuring 4 cm. in breadth. The artificial opening in the lesser omentum was 1.5 cm. long and 1.25 cm. wide.

In McKenzie and Wood's case[15] vomiting was absent. Short,[20] in 1924, surveyed the 24 cases recorded up to then. McCrea[14] reported the presence of a greatly distended gallbladder which had herniated through the foramen of Winslow into the lesser sac. Gillis[8] states that either the large or small intestine may be involved.

Moynihan and Dobson[18] suggested that at least one of the following abnormalities predispose to the condition: (1) a common mesentery for the whole of the intestine; (2) the absence of secondary fusion of the ascending colon to the posterior abdominal wall; (3) an abnormally large foramen; (4) an abnormally long mesentery allowing undue mobility of the intestine.

Johnson[12] states that, according to Galch,[7] internal hernias comprise 0.9 per cent of hernias. Wangensteen[25] states that the greater number of patients are males and that usually the small intestine is involved. In less than one-third of the cases, portions of the large intestine, usually the appendix, ascending and transverse colon, have been found to be contents of the sac.

Venner[24] reported a case in which the stomach was pushed forward by a mass in the lesser sac. The mass consisted of the terminal ileum, cecum, appendix, and the ascending colon, including the hepatic flexure. The hepatic colon was stretched taut across the lower border of the stomach. The small intestine proximal to the lesion was not dilated, probably because of the pressure of the lesser sac on the posterior gastric wall.

Hollenberg[11] reported a case with a typical roentgenogram in which both a barium meal and enema done together enabled the diagnosis to be made. His diagnostic points were as follows: (1) compression of the stomach by an adjacent gas-filled bowel mass; (2) colonic obstruction at a site corresponding to the foramen of Winslow. The probable mechanism of this case is explained. An elongated right lobe of the liver was found along with adhesions extending between the liver and gall-bladder to the center of the transverse colon. It was postulated that this anatomical relationship served to direct the ascending colon and proximal portion of the transverse colon through the foramen of Winslow where strangulation occurred.

Lavarde and Chevret[13] stated that if the obstruction is at the mid-transverse colon, herniation through the foramen of Winslow should be strongly suspected if this obstruction does not have the appearance of a neoplasm. This type of herniation should also be suspected if the stomach is displaced anteriorly by a mass which has an air-fluid level.

Meusburger[16] states that it is not possible to make the diagnosis utilizing clinical findings alone but the roentgenographic plus the clinical picture does make the diagnosis definite.

Frimann-Dahl[6] states that if the large intestine penetrates into the omental bursa, a barium enema may show a tapered end toward the opening.

Mitchell,[17] Chesterman[2] and Dariau[3] have also reported cases. Hamilton and Hardy[9] reported a case in which an oval opening in the lesser omentum measuring $2\frac{1}{2}$ by $1\frac{1}{2}$ inches was found.

Edwards and Stewart[5] reported a case of eight hours' duration. They point out, using Cunningham as their authority, that in life the edges of the foramen of Winslow are in contact. They also mention the slow pulse rate of 64 in their case. The opening in the lesser omentum found in their case was considered acquired because no reason for a congenital opening in this situation could be postulated. Their patient possessed a well developed hepatoduodenal fold. They point out that this, along with the lesser omentum, acts as a funnel leading up to the foramen.

Chesterman[2] encountered an internal hernia which involved the lower ileum lying beneath Jackson's membrane.

Silverstone[21] described a case of his own and states that the acute cases fall into two groups—those in which obstruction occurs suddenly, and those in which symptoms of chronic indigestion have been present for years. He also states that small intestine is found in this situation twice as frequently as large intestine. Pain and vomiting are the main symptoms, he states. His case did not exhibit the paradoxical pulse rate mentioned by other authors.

Carling and Smith,[1] in 1925, published a case very similar to Hamilton and Hardy's[9] in which the middle 20 inches of ileum were involved.

Many writers mention Treves' case[22] which occurred in 1888. Here the ileum, cecum, ascending colon and part of the transverse colon had herniated into the foramen of Winslow and were all packed into the lesser sac, having also burst through the lesser omentum. Treves also mentioned 4 previous cases which had occurred respectively in 1834, 1842, 1884 and one which was undated.

Galch[7] states that:

1. Postoperative adhesions cause 30 per cent of all intestinal obstructions.
2. If we except obstructions due to external hernias, 50 per cent of all bowel obstructions are due to preceding laparotomy.
3. Over 82 per cent of all bowel obstructions are due to compression of the bowel.
4. Volvulus, intussusception, internal hernia and congenital abnormalities of the bowel account for about 16 per cent of all cases. All of these are partly or entirely due to congenital abnormalities. Volvulus and intussusception are included because they are not likely to occur unless the mesentery is abnormally long.

Puestow[19] presented a case of a patient

with a long right mesocolon which had allowed most of the ascending colon and the cecum to invaginate through a defect in the anterior abdominal wall.

ANATOMY

The foramen of Winslow is the communicating passage between the general peritoneal cavity and the lesser sac. It is bounded anteriorly by the free border of the lesser omentum which contains the common bile duct, hepatic artery and portal vein between its layers. Its posterior boundary consists of the peritoneum covering the inferior vena cava. Its superior boundary is formed by the peritoneum covering the caudate process of the liver. Its inferior border is formed by the peritoneum covering the superior and posterior aspects of the first and second portions of the duodenum and the origin of the hepatic artery.

PATHOLOGY

Various combinations of herniation may occur. Either the large or small intestine may be involved. A solitary duodenal diverticulum has been found to be the sole content within the lesser sac. Several cases have been reported in which the sac has ruptured and the contents have been found between the leaves of the transverse mesocolon. Other instances have occurred in which the contents have herniated through the lesser or greater omentum and reentered the general peritoneal cavity. They may be associated with pericecal or periduodenal hernias. The involved intestine is usually dilated and may perforate. The hernia may present itself anterior to the stomach by either stretching the lesser omentum or perforating it. In the latter instance, the general peritoneal cavity will have been entered. It also may present posterior to the stomach, distending the lesser sac and displace the posterior gastric wall.

The sac may be found between the stomach and spleen through the gastrolienal ligament with anterior displacement of the stomach and posterior displacement of the spleen. It may also herniate or perforate the lienorenal ligament between the spleen and left kidney displacing the spleen forward and to the left.

CLINICAL FEATURES

The symptoms of intestinal obstruction develop slowly. The pulse is often paradoxical. Little or no vomiting may occur. This is explained by the pressure upon the anterior or posterior aspects of the stomach which prevents the return of more intestinal contents once the stomach has been emptied by vomiting. There may be considerable intraluminal bleeding if infarction has occurred. The temperature may be normal.

TREATMENT

Treatment is entirely surgical. It is extremely important to recognize the fact that a serious lesion exists and to institute early laparotomy. The diagnosis at laparotomy is established by the presence of a cyst-like mass in or connecting with the lesser sac along with absence of a portion of the intestinal tract in the free peritoneal space. Often simple traction will reduce the hernia. It may be possible to fix the herniated portion of intestine so that a recurrence will not occur. Deflation of the herniated intestine, preferably through an opening in the gastrohepatic omentum may be necessary. It may be possible to reduce the hernia after gentle traction upon the epiploic foramen in an effort to enlarge it. In order to effect this, it may be necessary to make a short transverse incision through the gastrohepatic omentum above the duodenum, exert traction upon the common duct with the right hand and to pull the hepatic artery and portal vein to the left in an attempt to enlarge the foramen, depending upon the laxity of the retroperitoneal tissues. Resection of nonviable intestine may be required. Apparently the amount of strangulation rather than the actual time of strangulation affects the prognosis.

CASE REPORT

This white housewife, aged forty-four, was admitted with the chief complaint of "stomach ache and vomiting" of eight hours' duration.

Her present illness began following a substantial breakfast following which she experienced sudden mid-epigastric pain radiating to the back and to both upper quadrants. This was followed by the vomiting of a few ounces of yellowish fluid. Five similar episodes had occurred before her admission.

She appeared in some distress. Slight dehydration was present. Her abdomen presented remarkable tenderness over the mid-epigastrium with muscle rigidity. Slight tenderness over both lower quadrants was noted. Peristalsis was hyperactive in the left abdomen. Temperature 97° F., pulse 69, respiration 22, blood pressure 130/80, red blood cell count 4,140,000, hemoglobin 81 per cent, 12.5 gm., color index 0.99, white blood cell count 20,000 with 90 per cent polymorphonuclears, 7 per cent lymphocites and 2 per cent monocytes. Serum amylase was 73.1 units, Somogyi method.

Fig. 1. The plain supine film of the abdomen shows the stomach to be displaced to the left and downward by the gas-filled incarcerated cecum and proximal ascending colon. The dilated ascending colon proximal to the constriction at the foramen of Winslow is seen in the right hypochondrium. Several loops of dilated ileum are present in the lower abdomen.

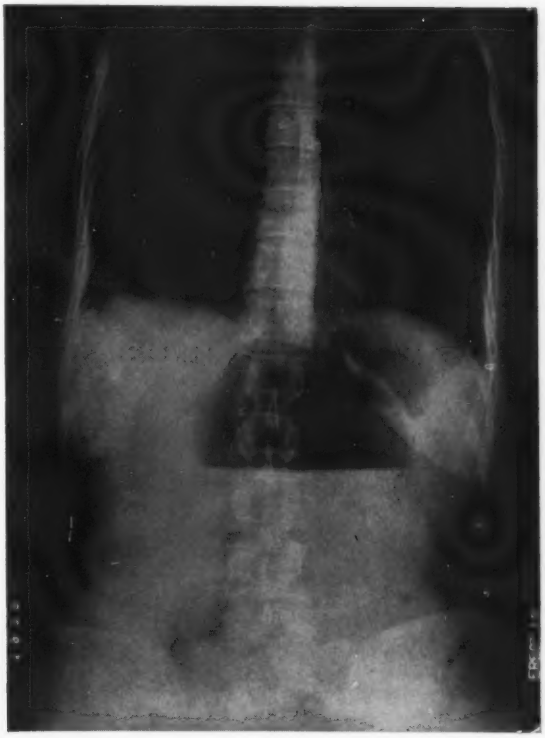


Fig. 2. The plain erect anteroposterior projection shows the presence of fluid levels in the displaced stomach and in the dilated incarcerated cecum and proximal ascending colon.

Operative Procedure. A high right rectus incision was made. There was considerable free serosanguineous fluid in the abdomen. The hepatic flexure, gallbladder, liver and stomach were pulled together in one mass. Considerable edema of this mass and of the superficial tissues was present. The first impression was that we were dealing with a walled-off, perforated duodenal ulcer. However, there was no fibrin or pus present. There was a loop of distended bowel above and posterior to the stomach, covered over by a thin layer of gastrohepatic omentum. The cecum and ascending colon were not present in their usual location.

The transverse colon was grasped and by gentle traction, the hepatic flexure, ascending colon, cecum and appendix and 12 inches of terminal ileum were delivered from the lesser sac into which they had herniated. The cecum and appendix were delivered last. All of these

Fig. 3. The erect left lateral film shows the gas-fluid containing dilated cecum and proximal ascending colon lying partially anterior to the stomach. A tube has been placed in the stomach and a small amount of rugar has been instilled.

structures had entered the lesser sac through the foramen of Winslow. The foramen admitted four fingers without difficulty. The appendix was moderately injected. The cecum was greatly distended and contained a gas-fluid level. It was, however, intact, without visible circulatory impairment. The terminal ileum, except for the herniated portion, and the remainder of the large intestine were normal. A large lymph node was noted behind the common duct.

The hepatic flexure was drawn upward and sutured anterior to the foramen of Winslow in such fashion that the cecum could not re-enter it. An appendectomy was then done. Although the cecum was abnormally mobile, it was felt that it could no longer enter the foramen of Winslow because of the above procedure.

The patient made an uneventful recovery.

Roentgen Diagnosis. The roentgen findings depend upon the presence of displacement of the stomach to the left by a mass which usually contains an air-fluid level. Anterior or posterior displacement of the stomach may occur, depending upon whether the mass remains in the sac or herniates through the ligaments comprising the lesser sac. The spleen may also be displaced. either anteriorly or posteriorly, depending upon the bulging of the gastrolienal ligaments or lienorenal ligaments. Multipositional views are essential.

If the large intestine is involved the barium enema reveals a taper pointing toward and into the foramen of Winslow with loss of normal continuity of the intestine. In the present case, the cecum and ascending colon are absent from the right abdomen and outlined above the stomach and in the lesser sac by a small amount

Fig. 4. An upper gastrointestinal series has been done. The stomach and duodenal cap are well outlined. A few feet of proximal jejunum are visualized. A barium enema was then done. This shows the cecum and ascending colon to be absent from their normal anatomical positions in the right abdomen. The ascending colon turns sharply to the left from the hepatic flexure and then ascends to a taper, pointing upward and to the left. The point of the taper is at the foramen of Winslow. A small amount of barium has passed through the constriction and outlines the incarcerated cecum and proximal ascending colon which lie within the lesser sac. The arrow points to the tapered portion of the displaced ascending colon.

Fig. 5. The right anterior oblique position again shows the presence of dilute barium in the incarcerated loop of cecum and proximal ascending colon. These distended portions of the large intestine displace the stomach to the left.

of barium which had passed through the constricted segment of bowel. Other organs may also be found in the lesser sac.

DISCUSSION

This case presents an uncommon cause of intestinal obstruction. It is important to recognize that herniation through the foramen of Winslow exists in order to alert the surgeon and relieve the patient before necrosis of the involved intestinal wall occurs. The roentgenographic findings are highly suggestive, if not pathognomonic.

SUMMARY

A case of herniation through the foramen of Winslow has been presented and the roentgenographic findings noted. These consist of the presence of a gas-fluid distended loop of large or small intestine adjacent to the stomach in the plain roentgenograms. These loops may be either anterior or posterior to the stomach, depending on the direction of the herniation.

If the large intestine is involved, the barium enema shows absence of the herniated portion of the large intestine from its usual location in the abdomen and the presence of a tapered barium shadow at the site of herniation pointing toward the foramen of Winslow.

25 Park Ave.
Binghamton, New York

REFERENCES

1. Carling, E. R., and Smith, A. T. Hernia through foramen of Winslow: secondary rupture through gastro-hepatic omentum. *Brit. J. Surg.*, 1925–1926, *13*, 585–586.
2. Chesterman, J. T. Unique internal hernia. *Brit. J. Surg.*, 1941–1942, *29*, 278–279.
3. Dariau, E. A. Etranglement interne dans l'hiatus de Winslow. *Gaz. d. hôp.*, 1939, *112*, 393–394.
4. Dewis, J. W., and Miller, R. H. Hernia through foramen of Winslow; report of case with reference to 33 other cases collected from literature. *Surg., Gynec. & Obst.*, 1927, *45*, 95–102.
5. Edwards, H., and Stewart, W. Hernia through foramen of Winslow, emerging through gastro-hepatic omentum. *Brit. M. J.*, 1943, *1*, 343–345.
6. Frimann-Dahl, J. Roentgen Examinations in Acute Abdominal Diseases. Charles C Thomas, Springfield, Ill., 1951, p. 151.
7. Galch, W. D. In: Lewis, D., Practice of Surgery. W. F. Prior Company, Hagerstown, Maryland. Vol. VII, Chap. 7, p. 21.
8. Gillis, L. Hernia through foramen of Winslow. *Lancet*, 1946, *2*, 48–49.
9. Hamilton, I., and Hardy, J. E. S. Hernia through foramen of Winslow emerging through gastro-hepatic omentum. *M. J. Australia*, 1946, *1*, 805–807.
10. Haxton, H. A. Hernia of caecum into lesser sac of peritoneum complicated by volvulus. *Brit. M. J.*, 1944, *2*, 792.
11. Hollenberg, M. S. Radiographic diagnosis of hernia into lesser peritoneal sac through foramen of Winslow. *Surgery*, 1945, *18*, 498–502.
12. Johnson, J. R. Internal hernia. *Arch. Surg.*, 1950, *60*, 1171–1182.
13. Lavarde, J., and Chevret, R. Contribution à l'étude radiologique des occlusions; hernie étranglée de l'hiatus de Winslow. *Presse méd.*, 1949, *57*, 562–563.
14. McCrea, A. N. Herniation of gall-bladder through foramen of Winslow. *Brit. J. Surg.*, 1951, *38*, 386–387.

15. McKenzie, W. G., and Wood, D. Strangulated hernia through foramen of Winslow. *Brit. J. Surg.*, 1924–1925, *12*, 613–614.
16. Meusburger, A. Akute Darmeinklemmung im Foramen Winslovii. *Zentralbl. f. Chir.*, 1940, *67*, 1880–1881.
17. Mitchell, G. F. Acute intestinal obstruction in baby 15 months old; hernia through foramen of Winslow. *Brit. J. Surg.*, 1938–1939, *26*, 648–649.
18. Moynihan, B. J. A., and Dobson, J. F. Retroperitoneal Hernia. Second edition. London.
19. Puestow, C. B. Intestinal motility and postoperative distention; experimental and clinical studies. *J.A.M.A.*, 1942, *120*, 903–908.
20. Short, A. R. Retroperitoneal hernia. *Brit. J. Surg.*, 1924–1925, *12*, 456–465.
21. Silverstone, M. Hernia through foramen of Winslow. *Lancet*, 1939, *2*, 786–787.
22. Treves, F. Hernia into foramen of Winslow. *Lancet*, 1888, *2*, 701–704.
23. Ullman, A. Hernia through foramen of Winslow. *Surg., Gynec. & Obst.*, 1924, *38*, 225–233.
24. Venner, B. Hernia through foramen of Winslow. *M. J. Australia*, 1949, *2*, 678.
25. Wangensteen, O. H. Intestinal Obstruction. Second edition. Charles C Thomas, Springfield, Ill., p. 370.

Vol. 72, No. 2

ROENTGEN MANIFESTATIONS OF EPIDURAL GRANULOMAS OF THE SPINE*

WITH A REPORT OF TEN CASES

By JOHN A. CAMPBELL, M.D., *and* RICHARD A. SILVER, M.D.

INDIANAPOLIS, INDIANA

AMONG the disease processes which involve the contents of the spinal canal are a group of acute and chronic inflammatory tumors arising in the extradural space and manifesting themselves as localized mass lesions. These are the so-called "epidural granulomas." Although the neurosurgical literature contains many reports of these lesions,[3,6,11,18,21] there is little mention of their roentgen manifestations.

According to Hirschfield and Yaskin,[9] the first report of this condition was made by Bergamaschi[1] in 1820. By 1926, Dandy[5] had found 25 cases in the literature and added 3 of his own. Cohen[4] cites 88 reported cases occurring between 1855 and 1937. The apparent rarity of this condition is more the result of missed diagnosis than infrequency of incidence.

CLINICAL SYNDROMES

The acute type occurs as a liquefying epidural abscess and runs a rapid or sometimes fulminating course. The patient is generally young and gives a history of a previous infection which usually antedates the onset of back symptoms from two to four weeks. Classically, there is sudden onset of excruciating, unrelenting pain in the back or along the course of the spinal nerves or in the legs. This pain is more severe than pain which is encountered with cord tumors. After a latent period of about one week, disabling neurological symptoms appear. These may develop sensory and sphincter disturbances to complete paraplegia within forty-eight hours. The patient is septic with fever, malaise, sweats, and leukocytosis. The spinal fluid almost invariably shows an increase in cells and protein.

At operation, the epidural space may contain a localized abscess, or just as often, the entire length of the epidural space is filled with pus. Often the first clue to the diagnosis occurs when pus is obtained through the spinal puncture needle before the subarachnoid space is entered. Browder and Meyers[2] report one lesion with bone involvement at D_3 which extended through the epidural space from C_4 to L_5.

The chronic granulomas are solid inflammatory masses often developing so insidiously as to give rise to deceptive clinical and roentgenological findings. The syndrome of this group has certain characteristics which differ from those of the acute process. The pain is not so severe, and is slower in onset. A history of preceding infection is frequently not obtained. When it is, this infection antedates the symptoms by months, rather than days or weeks. The sensory disturbances and paresthesias are apt to be transient and fleeting at first, only to become more severe and persistent as the months go by. Gradually motor and sensory paralyses occur. Spinal fluid studies may show a block, elevated protein, xanthochromic fluid, and an increase in lymphocytes.

At operation, a fairly discrete, firm mass is encountered. This may vary greatly in size. The specimen of one of Dandy's[5] cases weighed 15 grams. The lesion also varies in length, sometimes reaching 10 centimeters.

ANATOMICAL ASPECTS

The spinal epidural space (Fig. 1) is bounded by the dura surrounding the cord and by the internal ligaments of the vertebral canal. It contains fat, blood vessels

* From the Department of Radiology, Indiana University Medical Center, Indianapolis, Indiana. Presented at the Fifty-third Annual Meeting, American Roentgen Ray Society, Houston, Texas, Sept. 23–26, 1952.

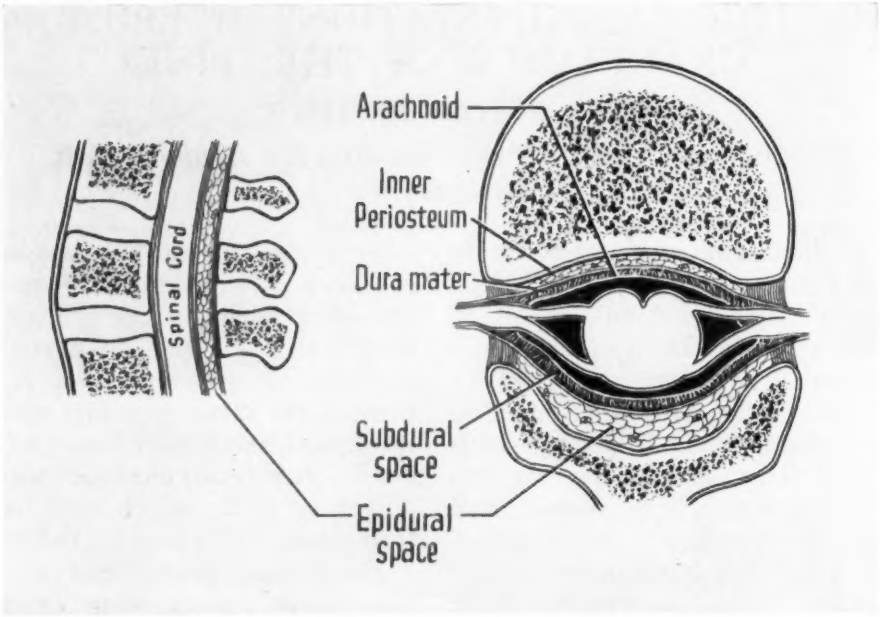


Fig. 1. *Anatomy of the Epidural Space.* The spinal epidural space is bounded by the dura surrounding the cord and by the periosteum of the vertebral canal. It extends from the first cervical to the second sacral segment. An actual space exists posterior to the cord, whereas anteriorly it is only a potential one.

and areolar tissues. Below the second sacral level, the epidural space completely surrounds the dura. From the first cervical to the second sacral segment, however, it is only a potential space anteriorly and anterolaterally, for here the dura is closely applied to the bone of the vertebral bodies. Posterior to this, an actual space exists. This anatomical relationship is important clinically in that although cases have been reported occurring ventrally,[13,14,15] the vast majority occur dorsally where the true space exists. Anatomically, the size of the epidural space varies with different levels. It is smallest in the cervical region, gradually deepens in the dorsal area, and then tapers until the level of the second lumbar body is reached. Here it enlarges again and assumes its deepest proportions. This is the probable explanation why the majority of lesions occur either in the mid-dorsal or lumbar regions.[8]

PATHOLOGICAL ASPECTS

Epidural inflammations occur either by direct extension from a contiguous infected area or by metastasis from a more distant infection. Many cases have been reported where no primary infection could be found elsewhere in the body at autopsy, and were hence assumed to be primary in the epidural space.[5,16,19] There is some controversy over this point because other authors believe that in all such cases a small occult focus of vertebral osteomyelitis exists from which the process extends to the epidural space,[2,10,20] This focus may be so small that is is not detected unless carefully searched for at autopsy. Microscopically, the granulomatous mass shows the picture of chronic inflammation with macrophages and giant cells interspersed in a network of fibrous and hyaline tissue.

While epidural infections are most frequently of staphylococcic or tuberculous origin, a variety of other etiologic agents have been reported.

ROENTGEN CONSIDERATIONS

Since epidural granulomas can produce irreversible or serious cord damage frequently leading to fatal outcome, their detection by roentgenologic means is of diagnostic importance. In general, there

Table I

ETIOLOGIC AGENTS IN EPIDURAL GRANULOMAS

Infectious
1. Staphylococcus
2. Pneumococcus
3. Streptococcus
4. Tuberculosis
5. Brucella
6. Syphilis
7. Torula
8. Actinomycosis
9. Blastomycosis
10. Typhoid

Other
1. Eosinophilic granuloma
2. Lymphoid hyperplasia

is no pathognomonic roentgen appearance which invariably distinguishes these lesions from extradural neoplasms. However, any roentgen evidence of inflammatory changes in the spine of a patient with unexplained pain in the back or extremities is sufficiently indicative of an epidural granuloma to warrant emergency investigation.

The useful procedures in the roentgen diagnosis of these conditions are plain films of the spine, laminagraphy of a spinal segment, and myelography. Plain roentgenograms are often completely negative; nevertheless they should be obtained first. Such roentgenograms may yield one or more of the following findings.

These are the findings of vertebral osteomyelitis, intraspinal pressure, and perivertebral inflammation. Although some authors feel[7] that epidural extension of greater or lesser degree invariably accompanies vertebral osteomyelitis, many cases show no clinical evidence of this. Roentgen changes in the neural arch and extravertebral areas are most significant because it is from these locations that the highest incidence of epidural extension occurs. When several adjacent vertebrae are involved, a surrounding paravertebral density is a constant feature. This may obscure the underlying bone changes unless laminagraphy is utilized.

More decisive to diagnosis, however, are the myelographic findings. Completely

Table II

PLAIN ROENTGENOGRAM FINDINGS IN EPIDURAL GRANULOMAS

Vertebral Body
1. Demineralization; loss of marginal definition
2. Beveling of vertebral edges; absence of bony plate
3. Destructive changes
4. Collapse; infraction
5 Sclerotic zone adjacent to disc

Neural Arch
1. Demineralization; loss of definition
2. Loss of white line around pedicles (especially medially)
3. Destructive changes; pedicles, lamina, spinous process
4. Widening of spinal canal; intervertebral foramen

Extravertebral
1. Scoliosis or kyphosis
2. Paraspinal soft tissue density
3. Destruction of vertebral end of rib
4. Narrowing of intervertebral disc

negative myelography, in our opinion, practically excludes this condition. The pertinent changes found on cisternal or lumbar myelography are listed in Table III.

Table III

MYELOGRAPHIC FINDINGS IN EPIDURAL GRANULOMAS

1. Smooth, extrinsic indentation of lateral margins of oil column
2. Thinning and tapering of caliber of oil column above or below lesion
3. Marked ductility of head of radiopaque column proximal to obstructing lesion
4. Abrupt extradural obstruction, often at a level some distance from the neurological level
5. Incomplete extradural obstruction with irregular splitting of oil column

Early in their course, epidural granulomas cause an indentation of one margin of the opacified subarachnoid space which extends over one or more vertebral segments, depending upon the size of the tumor. The greatest deformity of the oil column is at the center of the mass with the caliber of the subarachnoid space returning by degrees to normal above and below the lesion. If the inflammatory

tumor develops rapidly, this myelographic evidence will be manifest before roentgen changes are observed in the neural arch. When the granulomas are of sufficient size, the dural sac may be compressed so that the contrast outline of the subarachnoid cavity tapers to a point of complete obstruction. Marked ductility of the head of the radiopaque column is seen in this instance. In more advanced disease, the subarachnoid space is abruptly collapsed without tapering as a result of angulation of the dural sac and spinal cord by the lesion. Frequently, the myelogram will show the advancing margin of the lesion at a considerable distance beyond the level of bone involvement.

Some of the roentgen variations from case to case are exemplified in the following reports.

CASE REPORTS

CASE I. B.B. This twelve year old white girl was admitted to the Pediatric Service with a tentative diagnosis of rheumatoid arthritis or kidney infection. Three weeks prior to admission she had had influenza and recovered. Nine days prior to admission she began complaining of pain in the left side of her back in the region of the 11th and 12th ribs. Three days later, she developed a temperature of 103° F. The back pain was sudden in onset, extremely severe, and persistent. It was not relieved by any change in position, athough the patient was more comfortable when sitting upright. The patient had had no bowel movement for one week.

On physical examination she was acutely ill and complained bitterly of the pain in her back. This localized over D6. On deep palpation of the abdomen, pain could be elicited in the region of the left costovertebral angle. There were no neurologic changes or pathological reflexes.

Laboratory examination revealed negative urinalysis. The serology was negative. The hemoglobin was 14 grams and the white blood cell count on admission was 14,600. Examination of the spinal fluid showed an increase in white blood cells. On admission there were 210 white blood cells with 90–95 per cent lymphocytes. The Pandy test was positive, sugar equaled 29 mg. per cent and total protein was 360 mg. per cent.

Roentgenographic examination of the cervical, dorsal, and lumbar spine showed no abnormality (Fig. 2). Myelographic studies were performed and a complete block of the pantopaque column was found at the level of D_9 (Fig. 3).

At operation, thick yellow pus was found in the epidural space from D_4 to D_{10}. Culture of this pus revealed the causative organism to be hemolytic *Staphylococcus aureus*. The patient made an uneventful recovery.

Comment. This case illustrates an acute process with a fulminating course. The timely use of myelography provided early diagnosis and cord damage was completely avoided. The myelographic block at D_9 marked the lower limit of a lesion which extended from that level upward to D_4, in a patient whose clinical findings indicated a lesion at D6.

CASE II. E.H. This white male, aged eighteen, was admitted to the hospital complaining of inability to void and inability to use his lower extremities. Two weeks prior to admission, he developed a painful swollen left knee. This was followed in a few days by backache which had been severe and persistent. Even on complete bedrest, the pain in the back was not relieved. On the day prior to admission, he first noted he was unable to use his lower legs and that his neck was stiff. Temperature at that time was 103°F. He had been unable to void for about forty-eight hours.

Physical examination showed some tenderness to palpation in the abdomen. The bladder was distended. The rectal sphincter was relaxed. The neurological examination showed anesthesia below L_1 with hypalgesia above that level to D8. There was complete motor paralysis of both lower extremities.

Laboratory findings showed normal urinalysis, negative serology, normal red blood cell count and hemoglobin, white blood cell count 20,000 with a shift ot the left. Spinal fluid examination revealed clear sparkling fluid with normal pressure and microscopic findings. Plain roentgenograms of the dorsal spine showed scoliosis to the right at D_7 (Fig. 4). The surrounding paraspinal soft tissue density obliterates the outline of the left side of the neural arch and transverse process at this level.

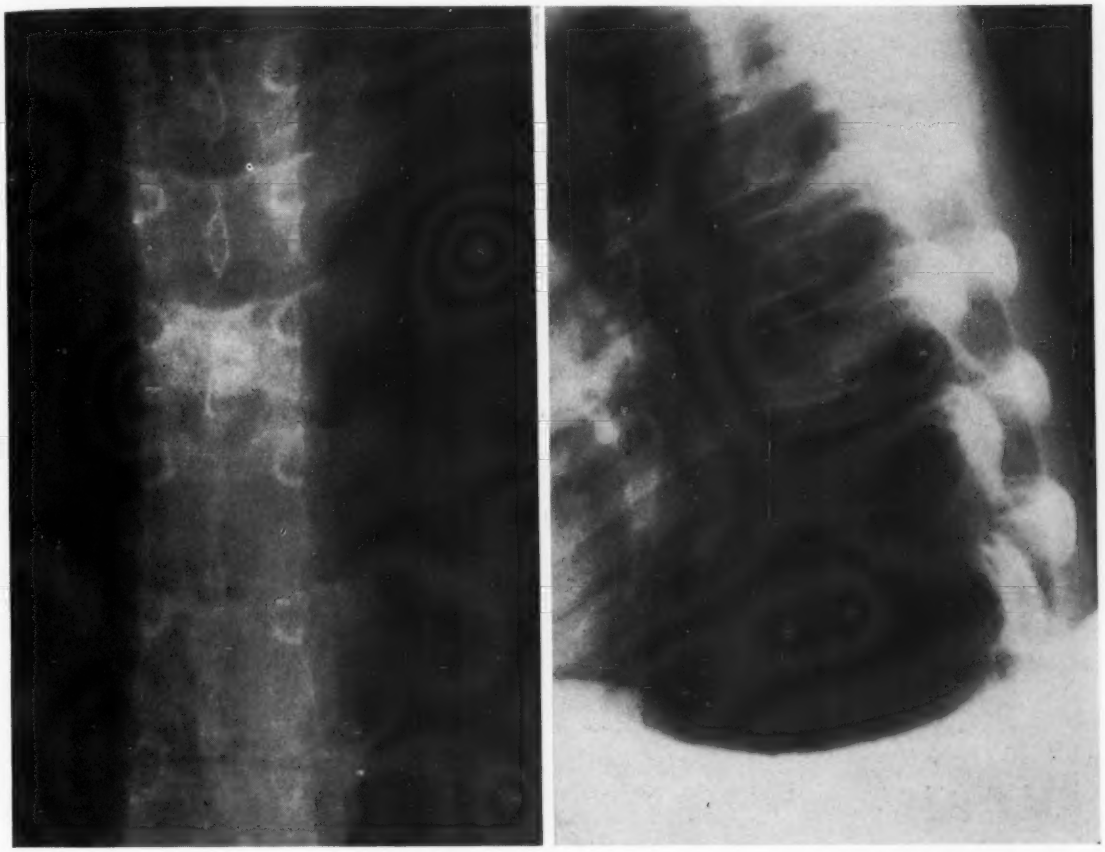


Fig. 2. Case I. *Acute Epidural Granuloma of Mid-dorsal Spine.* Spot roentgenograms of the 6th dorsal vertebra as well as plain films of the entire dorsal spine, were completely negative.

Subsequent myelography showed complete block of the column at the level of the 7th dorsal interspace (Fig. 5). Laminectomy was performed and an epidural abscess was found at the level of D5 to D7. This was of the granulomatous type with many honey-combed areas of encapsulated purulent material. Smear and culture were taken which were negative for acid fast bacilli but positive for *Staphylococcus aureus*. As much of this tissue as possible was removed, and the underlying dura appeared normal. The histopathologic features of this material showed acute purulent inflammation.

Postoperatively, the patient showed a slow return of motor and sensory function and did become able to void voluntarily. His postoperative course was complicated by fever which was subsequently traced to osteomyelitis of the entire left femur. He has recovered fairly well from this complication and continued to regain motor function. When last seen, he was employed, was walking quite well with use of a cane, and apparently has made a satisfactory recovery.

Comment. This patient exhibits an epidural abscess of metastatic origin in that it was believed to represent a part of a hematogenous infection which manifested itself in the back as well as in the femur. The proximity of the paraspinal density obliterated the bony outlines and probably prevented the demonstration of any underlying osteomyelitic changes on the plain roentgenograms. Laminagraphy might have confirmed this possibility.

Case III. C. C. This seventeen year old high school student was admitted to Indiana University Medical Center complaining of back pain and inability to use his legs. He had been well until three months prior to admission when he noted pain in the back which radiated

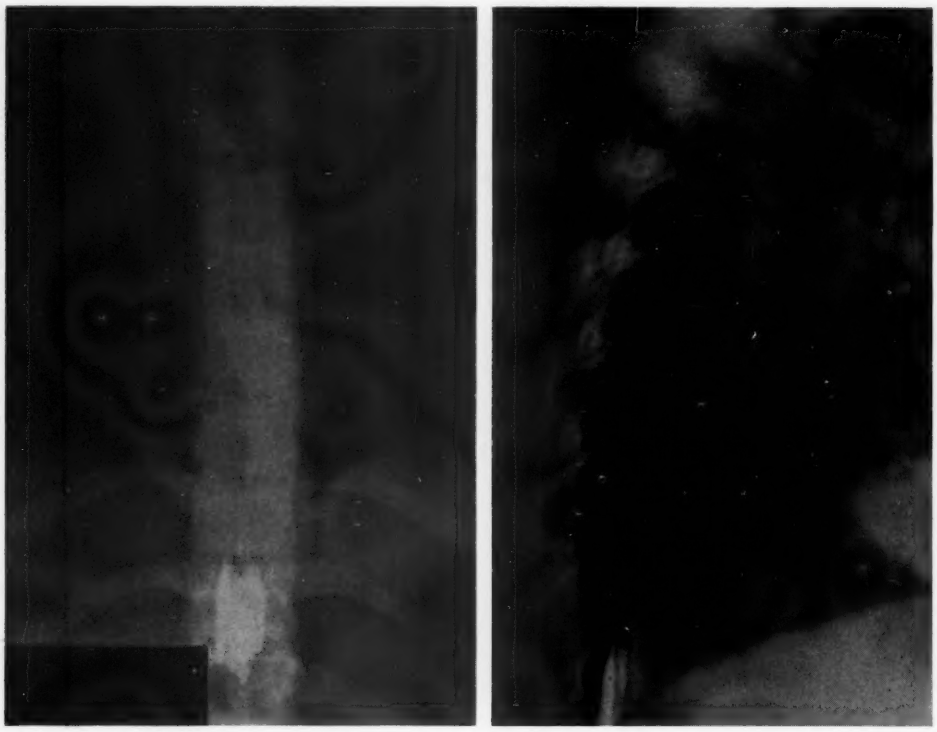


FIG. 3. Case 1. *Acute Epidural Granuloma of Mid-dorsal Spine.* Lumbar myelography shows extradural type of block at D9 with irregularity of the upper end of oil column. Lesion extended to D6 at surgery.

to the epigastrium and into the left lower quadrant. This was diagnosed as appendicitis, and an appendectomy was performed. This alleviated the pain for about two weeks. The pain returned and was then located in the upper lumbar region, did not radiate and was fairly constant. One week prior to admission he noticed inability to use his legs, which progressed steadily until complete paraplegia developed.

Physical examination showed that the patient was not acutely ill. There was no fever. Positive findings consisted of the neurological ones. Below T9 bilaterally there was hypalgesia which affected mainly the anterior thighs and buttocks. Tactile sensation was normal. Vibratory senses were lost below the iliac crest. Proprioception was impaired. Moderate paresis of both lower extremities with some spasticity on the left was noted. The knee jerk and ankle jerk were bilaterally hyperactive with positive Babinski and Chaddock signs. Abdominal reflexes could not be elicited.

Laboratory studies showed normal hemogram and normal urinalysis. Roentgen examination of the dorsal spine (Fig. 6) showed a destructive process involving the 8th dorsal vertebra with mottling and collapse of the body. The joint space was preserved. A soft tissue density was seen laterally to this body indicative of paravertebral abscess. There was destruction of the pedicle on the right. The roentgenographic impression was probable tuberculosis, with primary osteogenic sarcoma or lymphoma also considered.

In view of the roentgen findings and the symptoms of cord compression, the possibility of an inflammatory mass compressing the cord was entertained, and laminectomy performed. At operation the laminae of the 6th, 7th, and 9th dorsal vertebrae were removed. There was a fusiform enlargement of the epidural tissues with greatest thickness at the level of D8. This granulomatous mass was removed from the dura with some difficulty as it tended to envelop the cord and extend anteriorly. Cultures revealed the causative organism to be *Staphylococcus aureus*. Microscopic examination of the inflammatory mass showed the picture of chronic inflammation with no changes to suggest tuberculosis.

Progress films six months after surgery

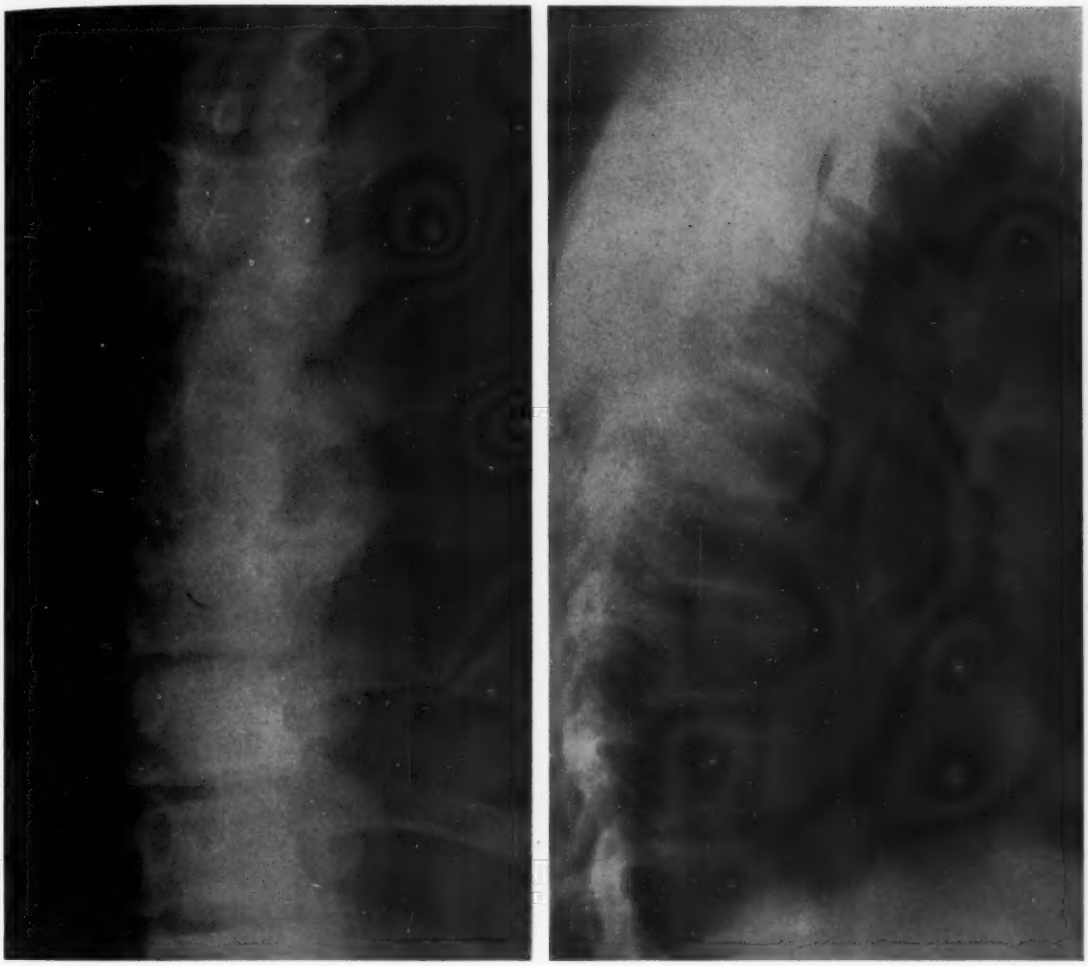


Fig. 4. Case II. *Epidural Granuloma at D7.* The plain films show scoliosis in the dorsal spine and a suggestion of paraspinal soft tissue swelling at D7. No vertebral body destruction is seen.

showed reduction in size of the soft tissue mass and an attempt at healing of the vertebra. This resolution is more rapid than is seen in tuberculous spondylitis (Fig. 7).

Comment. The clinical and roentgen findings in this case were such that myelography was not considered necessary for localization. Following laminectomy and antibiotic therapy, the progress films show an almost diagnostic acceleration in healing of the involved vertebra.

Case IV. H.T. This white male, aged fifty-five, was admitted to the hospital on January 19, 1951, with the chief complaint of inability to use his legs and numbness from the waist down. He had been well until five months prior to admission when he fell and hurt his back. Following that injury his back was sore intermittently, and two to three months before admission he developed pain which radiated around his chest over the entire lower part of his body. This pain continued until five days before admission, when, on sitting down, the patient felt something "snap" in his back and he was unable to move his legs after that time. At the same time he developed numbness below his waist and had shooting pains over the upper part of his chest. His bowels did not move from that time until the time of admission and he had dribbling incontinence of urine. During the month before admission he had had a productive cough, but otherwise there was no history of infection.

On physical examination there was slight

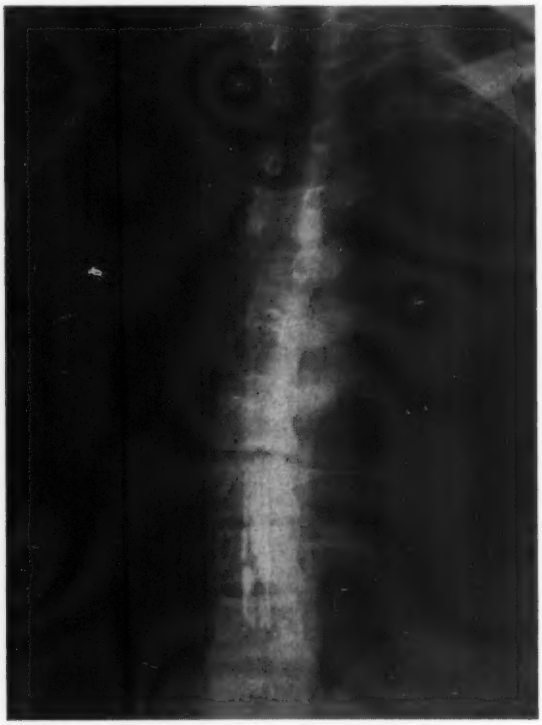


Fig. 5. Case 11. *Epidural Granuloma at D7.* Myelography shows complete obstruction and marked ductility of head of oil column at D7.

distention of the abdomen and early areas of ulceration over the sacrum. No other positive findings were present except the neurological examination. There was diminished sensation below the costal margins bilaterally and increased sensation above the costal margins to the level of the nipples. The patient had no voluntary motor power in his legs. Reflexes in upper extremities were normal. The abdominal and cremasteric reflexes were absent. Knee and ankle jerks were present and hyperactive. Bilateral ankle clonus was elicited and the Babinski sign was positive bilaterally.

Laboratory findings revealed normal urinalysis. The hemoglobin was 11 grams; red blood cell count was 3.61 million, white blood cell count 8,650, with normal differential. Examination of the spinal fluid showed 13 white cells, 850 red cells, with 6 lymphocytes. The Pandy test was 4 plus, sugar 34 mg. per cent, total protein 260 mg. per cent. Serology was negative.

Roentgen examination showed a destructive process involving D5 and D6 with loss of the interspace (Fig. 8). The pedicles were eroded. A soft tissue mass could be seen protruding in the paramediastinal region at the level of D6. Myelographic examination (Fig. 9) revealed a complete block at D6. There was capping of the head of the column with thinning of the column distal to the block. These findings were interpreted as indicative of an inflammatory lesion, probably epidural.

The patient was taken to surgery and a laminectomy over D5, 6, and 7 performed. Underlying these laminae was a granulomatous mass occupying the epidural space. A small abscess containing pus was also found at the level of D6. This pus was cultured and the causative organism found to be *Straphylococcus aureus*. The granulomatous mass was firm and fibrous, and quite vascular. It could be easily stripped off the dura. The microscopic sections showed it to consist of fibrous and fatty tissue with chronic inflammatory change. Approximately one month after laminectomy, the patient began to get some return of motor function and control of bowel and bladder. At the time of discharge, he could perform all movements with his legs except abduction. He was still too weak to stand alone. The patient has failed to return for any follow-up clinics.

Comment. This case is interesting in that diagnosis was made prior to operation and it presents a rather typical history for epidural granuloma of a chronic nature. The return of function even after two weeks of motor paralysis is encouraging.

Case v. B.V. This white woman, aged fifty-two, was admitted to the hospital as a diagnostic problem. She gave a history of pain in the back for eight months prior to admission. Three weeks before admission she was unable to walk. The pain did not follow an injury but developed suddenly. During the interval before admission to the hospital, the pains were intermittent between the shoulder blades, and quite severe at the time. During one of these attacks, she suddenly felt that she had lost control of her legs and from that time was unable to walk satisfactorily.

The physical examination was normal with exception of the neurological findings. There was marked weakness and incoordination of the lower extremities with loss of vibratory sensation. The Babinski test was positive on the left and questionably positive on the right. Knee and ankle jerks were hyperactive with unsustained ankle clonus. There was hyperesthesia up to the level of the rib margin anteriorly.

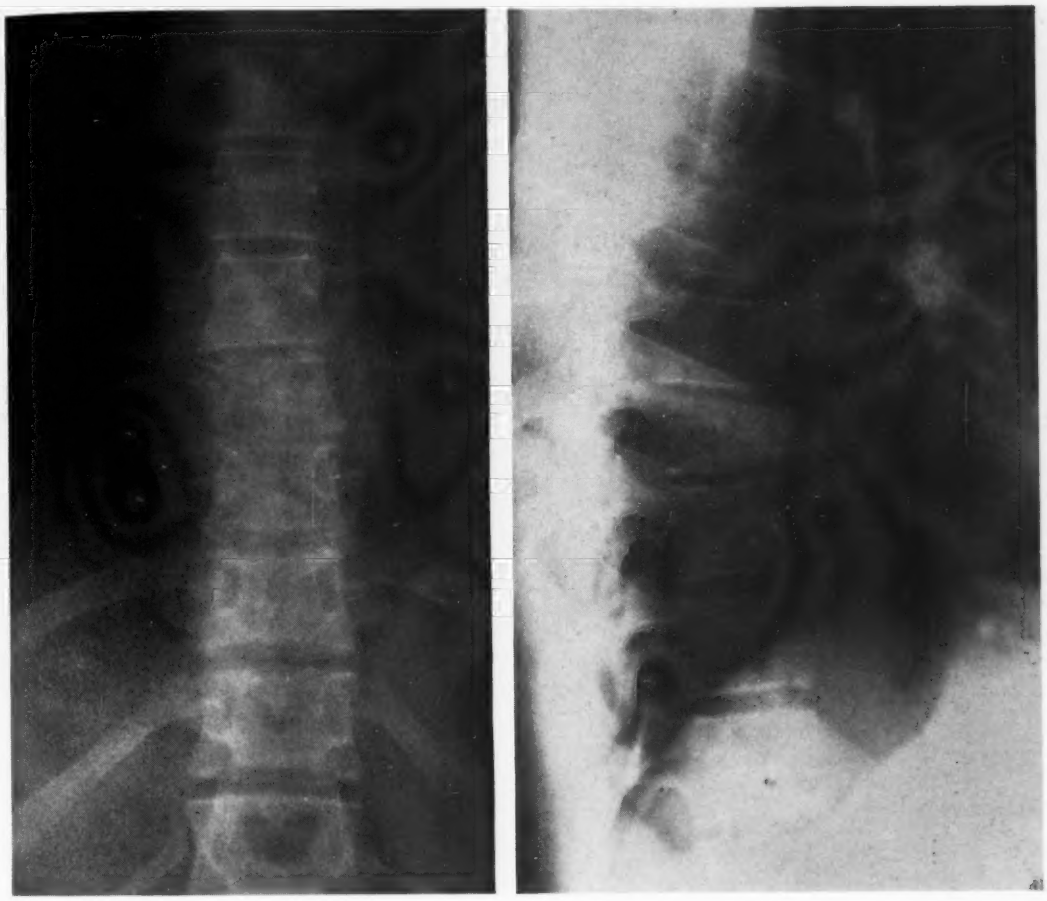


Fig. 6. Case III. *Chronic Epidural Granuloma with Neurological Manifestations.* There is destruction of the body of D8 with preservation of the intervertebral disc. The pedicles are indistinct, particularly on the right. Paraspinal soft tissue swelling is present.

Laboratory examinations revealed a normal urinalysis and hemogram. Patient was afebrile. Blood chemistry tests were normal.

Films of the dorsal spine (Fig. 10) showed roentgen changes in the left side of the 5th and 6th neural arches extending into the vertebral bones of the 5th rib. There was collapse of the body of D5 with kyphosis and narrowing of the intervertebral spaces above and below. In addition, the films of the skull revealed an osteolytic area of destruction in the left frontal bone about 2 cm. in diameter.

Although it was felt that we were dealing with metastatic carcinoma to the spine and skull from an unknown site, laminectomy was performed in an attempt to relieve the symptoms of cord compression. At operation an abnormal fatty tissue was encountered in the epidural space overlying D5 and a biopsy and cultures were taken. This lesion was shown to be an infectious granuloma involving not only the epidural spaces but the vertebral bodies as well, and the causative organism was found to be the cryptococcus (Torula).

This patient has made a fair recovery from her neurological symptoms in that she regained enough control of her extremities to walk.

Comment. This is an epidural granuloma resulting from direct extension of an involved vertebral body due to fungus infection. No diagnosis was made prior to the microscopic report of tissue removed at laminectomy.

Case VI. N.R. This colored female, aged twenty-one, was admitted to the hospital complaining of inability to move her legs. Two weeks before admission, she began to feel unsteady and weak. Complete paralysis of her lower extremities developed, and she became incontinent of urine and feces.

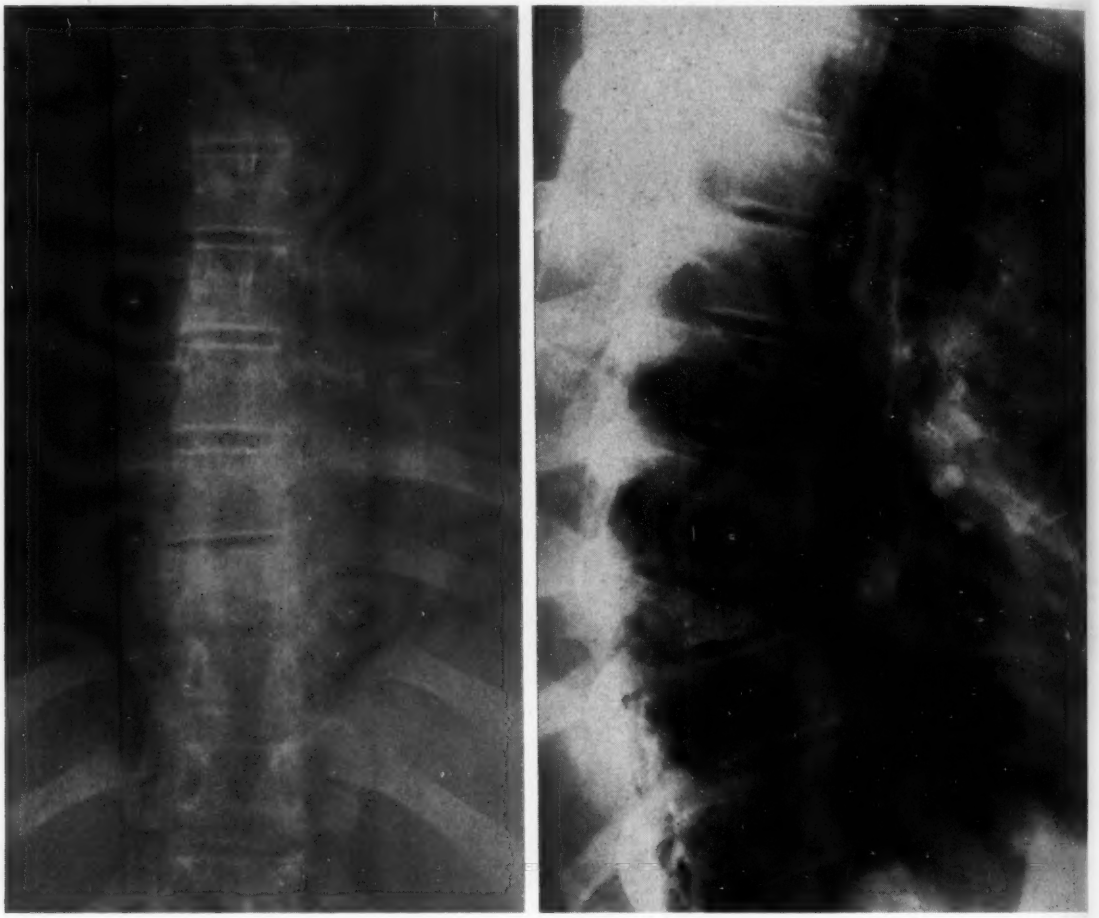


Fig. 7. Case III. *Chronic Epidural Granuloma. Progress Films after Laminectomy.* These films show a more rapid resolution of the process than would be expected if the osteomyelitis and epidural infection were tuberculous. The soft tissue swelling is decreased and there is beginning healing of the vertebral body.

Physical examination revealed flaccid paraplegia with absent tendon reflexes. There was hyperesthesia at the level of the xiphoid process—below that level all modalities were depressed. Physical examination also showed a draining sinus in the back at the level of D9.

Laboratory findings revealed negative urinalysis, red blood cell count normal, and white blood cell count 13,750; the Pandy test was 2 plus and spinal fluid protein 162 mg. per cent.

Roentgen examination of the chest showed a nodular mass protruding from the right mediastinum at the level of D5 and D6 and elevation of the right diaphragm. The adjacent posterior ribs were distorted and the intercostal spaces widened. Special views of the spine showed erosion of the articular tubercle of the 6th rib, and the inferior articular process and the transverse process of D5 on the right. There was enlargement of the intervertebral foramen between D5 and D6. The vertebral body and pedicles were normal. The roentgenographic inpression was a neurogenic tumor of the "dumbbell" type.

Myelography (Fig. 11) showed almost complete block of the column at the level of D5. The cord was deviated to the left. Impression was extradural tumor—neurofibroma, lymphoblastoma, ganglioneuroma, or infectious granuloma considered.

Laminectomy was performed from D2 to D7. Caseous material of granulomatous form was found above and below the spinous processes, in the neural canal, surrounding the dura both anteriorly and posteriorly. The portion surrounding the cord was firm, destroyed the 5th and 6th thoracic nerves, and was completely removed. The process was seen to ex-

Fig. 8. Case iv. *Chronic Epidural Granuloma of the Mid-dorsal Spine.* Plain films show advanced osteomyelitic changes in D5 and D6. The pedicles are eroded and the intervertebral disc space lost. A paravertebral soft tissue mass is present.

Fig. 9. Case iv. *Chronic Epidural Granuloma of Mid-dorsal Spine.* Myelography demonstrates almost complete extradural block at D6 with compression and irregular splitting of the oil column as it passes over the long lesion extending from D6 to D3.

tend anteriorly into the dorsal bodies and extrapleural space. The pathologic diagnosis was tuberculosis.

Although the dura pulsated well at surgery, the patient had no return of motor function, remained very weak, and died on the fifty-fourth hospital day.

Comment. This illustrates the epidural syndrome occurring without the usual severe back pain. This case represents a variant of Pott's disease which insidiously entered the epidural space and caused irreparable cord damage leading to fatal outcome.

Case vii. W.C. This white boy, aged sixteen, was admitted to the Long Hospital complaining of fever, general malaise, and pain in the right hip. The onset had been sudden two days prior to admission and the hip was more painful on motion. In spite of negative roentgen findings, a diagnosis of septic arthritis of the right hip was proposed. The patient soon developed a mass in the right lower quadrant that was not distinct but definitely palpable. The pain in the hip persisted. Roentgen examination (Fig. 12) showed swelling of the right psoas muscle with scoliosis. There was irregularity in the right sacroiliac region with soft tissue swelling. There was marked osteolysis of the pedicle and intervertebral margin of L3 on the right (see insert, Fig. 12). Spinal fluid examination has not been done. While in the hospital, the patient developed root pain, hyperesthesia of the toes on the right suggesting pressure on the sciatic and obturator nerves. Because of the persistence of these signs and symptoms, the area was explored through a retroperitoneal approach and an iliac abscess was found and drained. *Staphylococcus aureus* was cultured from this abscess but no other organisms. Postoperatively, his course was complicated by hemorrhage from the wound and a rather septic period following the surgery.

In addition, the mass tended to recur and approximately two weeks after the surgery, there was a definite mass palpable once again in the right lower quadrant. In addition, the pain

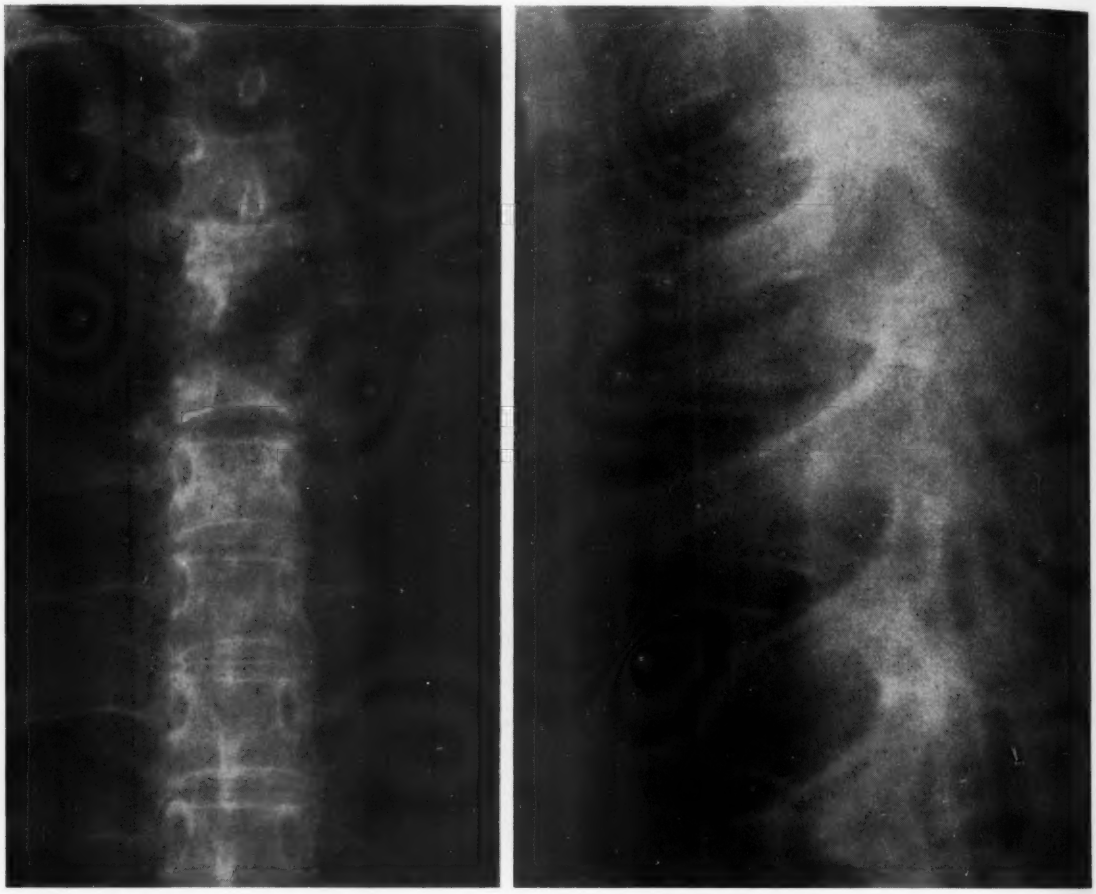


Fig. 10. Case v. *Torula Granuloma of Spine.* Plain films of dorsal spine show extensive osteolytic destruction of the bodies and neural arch of D4, D5 and D6 with extension into vertebral end of the 5th rib on the left.

in the right hip returned and was quite severe requiring opiates for relief.

The neurologic examination at this time revealed almost complete paralysis of the extension of the right foot and the everters of the right foot. Other motor functions were present but weak on the right. The right knee jerk was absent. Deep sensibility was normal in the right lower leg and pain and tactile sensibility was reduced. This was especially noticed over the area of L1, 2, and 3. The left lower extremity was entirely normal. The impression was an extraspinal involvement of L3, 4, and 5 nerve roots on the right.

The second operation showed an area of thickening and induration in the middle aspect of the psoas muscle. A small abscess cavity was found which extended down into the pelvis. This contained pus. Granulation tissue extended into the vertebral structure at L3. The abscess appeared to involve the bones of the pelvis but no definite sequestrum was palpated. This involved portion of bone included the ilium as well as the transverse processes of the lumbar vertebrae.

Comment. In this case, attention was focused on the abdominal mass and pelvic findings which were undoubtedly due to the iliopsoas abscess. The patient's major disability in the right lower extremity was actually due to an epidural granulomatous process in the mid-lumbar spine. In retrospect, this lesion should probably have been decompressed by laminectomy rather than drained by the abdominal route.

Case viii. L.C. This colored female, aged forty-two, presented a case history of stable pulmonary tuberculosis and recurrent attacks of cervical adenitis due to tuberculosis, the last of which had occurred eight years previously.

Fig. 11. Case VI. *Tuberculous Epidural Granuloma.* Roentgen examination showed a nodular paravertebral mass at the level of D5 and D6 on the right with elevation of the diaphragm. There was erosion of the articular tubercle of the 5th rib and the transverse process of D5. Myelography shows ductility of the obstructed oil column at D5.

She entered the hospital complaining of pain in the back, with radiation downward to the right leg.

Physical examination revealed a draining sinus in the midline of the back at the level of D12. Neurological examination was negative with the exception of some motor weakness in the right lower extremity.

Roentgen examination showed destruction of the spinous process and neural arch of D12 (Fig. 13).

At operation, a cold abscess was evacuated and it was seen to extend into the epidural space, but the dura appeared normal.

Comment. This case is an example of a subcutaneous infection with osteomyelitis of the spinous process producing the epidural syndrome. The osteolytic process had extended into the epidural space and sufficient cord compression was present to

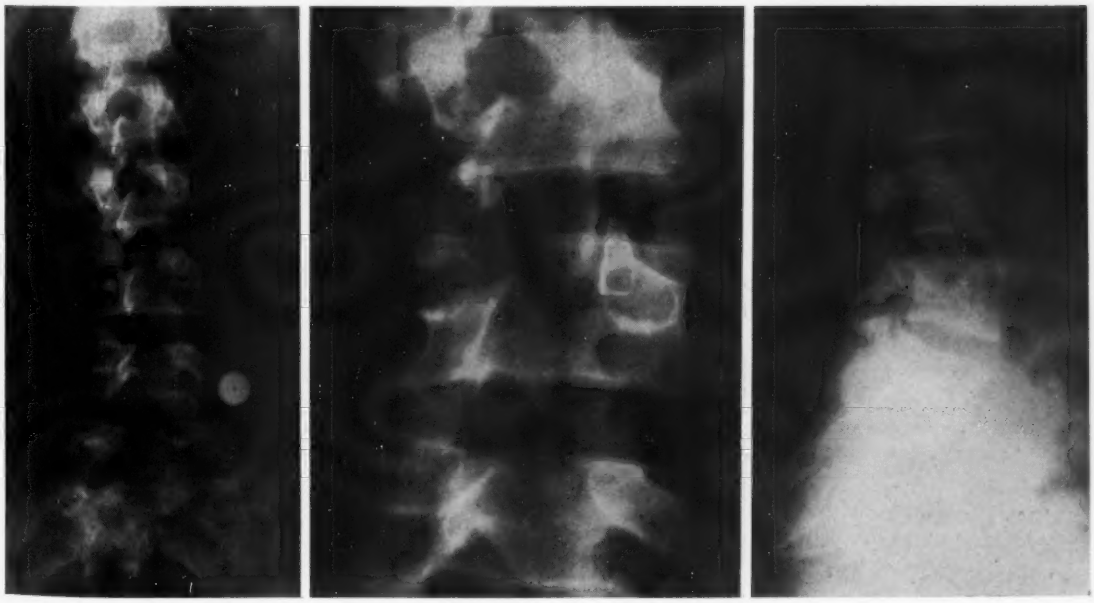


Fig. 12. Case VII. *Right Iliopsoas Abscess Producing the Chronic Epidural Syndrome.* There is osteolysis of the pedicle and upper lateral margin of body of L3 on the right. Surgery revealed an epidural extension at this level. Note enlarged psoas muscle and lateral scoliosis.

FIG. 13. Case VIII. *Subcutaneous Infection Causing the Epidural Syndrome.* The plain films show destruction of the spinous process of the neural arch of D12. At operation a tuberculous cold abscess had extended into the epidural space.

produce neurological findings. Following drainage of the abscess, there was complete recovery of all neurological function.

CASE IX. J.M. This white male, aged twelve, was admitted to the Pediatric Service complaining of a severe pain in the right gluteal region which had come on suddenly three days prior to admission. The pain had been unrelenting, and had increased in severity and extent. At admission, pain involved his hip and back. There were no other complaints. One day prior to admission his temperature had reached 103°F. and on admission it was 102.5°F. There was no history of previous trauma, injury, or infection. He had been well until the onset of this pain.

On examination he was acutely ill, exhibited marked opisthotonus, and appeared toxic. The skin was hot, face flushed, and he was dehydrated.

The significant physical findings consisted of spasm of the erector muscles in the back and the neurological findings. The deep reflexes in the extremities were hard to obtain because of spasms. Kernig and Babinski signs were positive bilaterally. Knee and ankle jerks were hyperactive and equal. There were no bladder or bowel disturbances.

Laboratory examinations revealed normal

urinalysis. Hemoglobin was normal. The white blood cell count on admission was 12,900 with a shift to the left. Spinal fluid examination revealed 300 white cells, 20 red cells. The differential count showed 83 per cent polymorphonuclears. The Pandy test was positive, 2 plus. On doing the lumbar puncture, pus was obtained through the spinal needle even before it entered the subarachnoid space and hence the diagnosis of epidural abscess was entertained. Films of the lumbosacral spine and pelvis showed no abnormality. Laminectomy was performed over L3 and L4. A layer of pus was found in the epidural space over this region. It extended from the level of L2 through L5. As much of the pus as possible was removed and cultures were made. The causative organism was found to be a *Staphylococcus aureus*.

Comment. The patient made an uneventful recovery. Reflexes gradually returned to normal. This case is interesting in that lumbar puncture yielded pus and made the diagnosis. Again, the history and findings are typical of acute epidural abscess and the condition was alleviated before any significant or permanent damage to the cord was done.

Case x. E.G. This white female, aged thirty-seven, was admitted to the University Hospital with complaints of severe pain centering over the lower neck and upper thoracic region of three week's duration; these were accentuated by coughing and sneezing. There was numbness of the entire body below the level of the umbilicus and there was some difficulty noticed in walking for the past three weeks. During the past six months there had been episodes of urinary retention requiring occasional catheterization for relief. There was no urinary incontinence. Frequently the patient experienced symptoms of pressure in the upper back. During the past three weeks she acquired an awkward gait with stumbling and falling episodes.

The patient received a four month series of intravenous and intramuscular injections for syphilis fifteen years ago. A few injections were repeated six years ago.

The neurological examination showed sensory changes below D12 with spasticity of the lower limbs and an ataxic gait. The reflexes were hyperactive. There was a positive Babinski and Chaddock sign bilaterally. Tenderness to percussion was elicited over the spinous processes of D4 to D8 inclusive. There was no motor or sensory involvement of the upper limbs. A diagnosis of cord compression syndrome was made, probably due to syphilitic arachnoiditis.

Fig. 14. Case x. *Epidural Granuloma Due to Syphilis.* The plain films of the upper dorsal spine show reactive bone changes on the right lateral margin of D3 and D4.

Plain roentgenograms (Fig. 14) of the upper dorsal spine showed reactive bone production on the right lateral border of D3 and D4. Myelography (Fig. 15) shows splitting of the oil column from D12 to D5 with a smooth extrinsic indentation along the right lateral margin. Abrupt extradural obstruction is seen at the level of the third dorsal interspace.

Spinal fluid showed moderate pleocytosis with a total protein of 312 mg. per cent. The Mazzini complement fixation test for syphilis was reported as 4 plus on several occasions. The Kolmer cardiolipin test was 3 plus.

Laminectomy was performed and disclosed a fleshy gray granulomatous mass in the posterior epidural space extending from D1 to D4.

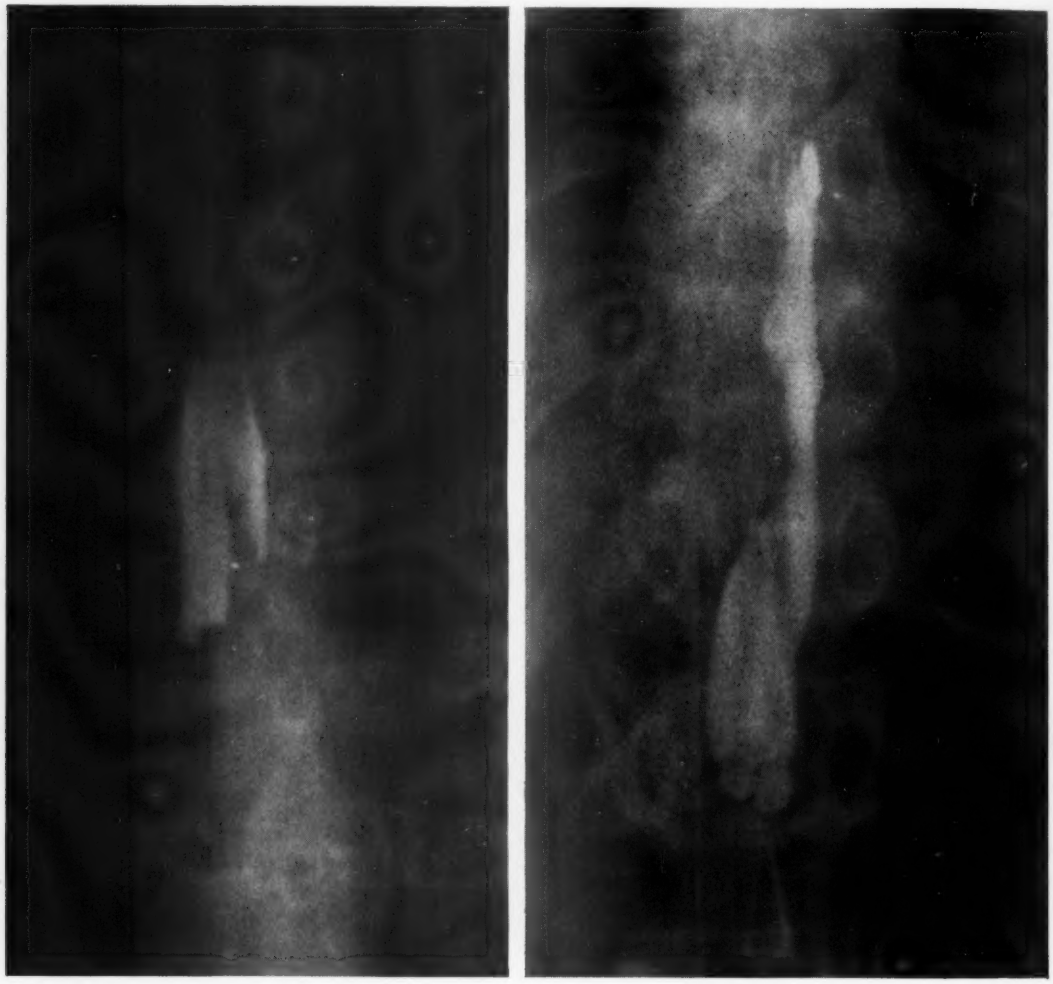


Fig. 15. Case xi. *Epidural Granuloma Due to Syphilis.* Myelography shows splitting of the oil column from D12 to D5 with a smooth, extrinsic indentation of the right lateral margin. Abrupt extradural obstruction is seen at the level of the 3rd dorsal interspace.

The greater part of this mass was removed by blunt dissection leaving behind some tissue extending into the lower thoracic area.

Comment. This patient had tertiary syphilis with multiple neurological complaints. There were extensive syphilitic inflammatory changes in the epidural space over the entire dorsal spine as shown by myelography. The compression syndrome arose from a bulky granulomatous mass covering the upper dorsal segments.

DIFFERENTIAL DIAGNOSIS

Shenkin, Horn and Grant[17] analyzed 54 extradural compressive lesions; of these, about 50 per cent were due to metastatic malignancy; 25 per cent to epidural infections, and 15 per cent to primary epidural tumors. The remainder were composed of congenital cysts, lymphomas, and post-traumatic conditions.

Roentgenologically, metastatic neoplasms are confused with the chronic granulomas but tend to involve more than one segment of the spine. They produce more osteolysis of the vertebral bodies and generally show evidence of involvement elsewhere. Benign epidural tumors are less frequent, less painful, and seldom produce bone changes. Lymphomas are the

commonest malignant epidural tumors, and are most difficult to differentiate unless associated with itching of the skin, sclerotic bone changes, or systemic involvement.

Congenital extradural cysts are distinguished by their benign symptomatology, greater fusiform enlargement of the vertebral canal, and exclusive orientation to the mid-thoracic spine of adolescents. Other diseases of the nervous system, including poliomyelitis and meningitis, are excluded by the negative roentgen findings.

SUMMARY AND CONCLUSIONS

The clinical and roentgen aspects of ten cases of epidural granuloma have been presented:

1. These lesions produce a definite clinical syndrome of boring back pain, infection, radiculitis, and spinal cord damage.

2. The majority of these lesions develop in the mid-dorsal spine of individuals in the younger age groups.

3. They occur as a complication of vertebral osteomyelitis or by direct extension from an infection adjacent to the vertebral column.

4. They arise more commonly when the osteomyelitic focus involves the neural arch.

5. The presence of a paraspinal soft tissue mass in patients presenting the clinical epidural syndrome usually denotes an underlying osteomyelitis of the vertebra even when destructive changes are not demonstrated on plain roentgenograms.

6. This condition should be searched for myelographically whenever there is roentgen evidence of vertebral osteomyelitis.

7. In acute cases, positive myelographic findings are frequently present before bone or soft tissue changes become demonstrable.

8. From the standpoint of differential diagnosis, completely negative myelography excludes this complication.

9. All grades of inflammatory reaction between abscess formation and the production of granulomatous tissue are capable of a similar roentgen and clinical syndrome, regardless of etiology.

10. Although the roentgen changes in these granulomas vary from case to case and are not pathognomonic in themselves, careful correlation with the clinical findings will generally allow differentiation from metastatic malignancy and other extradural lesions.

11. Early recognition of this condition allows neurosurgical intervention before irreparable cord damage develops.

John A. Campbell, M.D.
1040 West Michigan St.
Indianapolis, Indiana

The authors are indebted to Dr. Robert Heimberger of the Department of Neurosurgery and Dr. Orville T. Bailey of the Department of Neurology of Indiana University for their valuable assistance in the preparation of this paper and for the case material which they made available.

REFERENCES

1. Bergamaschi, G. Sulla mielitide stenica e sul tetano loro identità, metodo di cura, e malattie secondarie, che se derivano oservazioni. G. Torri, Pavia, 1820.
2. Browder, J., and Meyers, R. Infections of spinal epidural space; aspect of vertebral osteomyelitis. *Am. J. Surg.*, 1937, *37*, 4–26.
3. Campbell, M. M. Pyogenic infections within vertebral canal. *Bull. Neurol. Inst. New York*, 1937, *6*, 574–591.
4. Cohen, I. Epidural spinal infections. *Ann. Surg.*, 1938, *108*, 992–1000.
5. Dandy, W. E. Abscesses and inflammatory tumors in spinal epidural space (so-called pachymeningitis externa). *Arch. Surg.*, 1926, *13*, 477–494.
6. Echols, D. H. Emergency laminectomy for acute epidural abscess of spinal canal. *Surgery*, 1941, *10*, 287–295.
7. Freeman, L. W. Personal communication.
8. Gasul, B. M., and Jaffe, R. H. Acute epidural spinal abscess—a clinical entity. *Arch. Pediat.* 1935, *52*, 361–390.
9. Hirschfield, B. A., and Yaskin, J. C. Spinal epidural lesions with report of 3 cases. *M. Times*, New York, 1939, *67*, 107–112.
10. Hunt, J. R. Acute infectious osteomyelitis of spine and acute suppurative perimeningitis. *Med. Rec.*, 1904, *65*, 641.
11. Ley, A., Jacas, R., and Oliveras, C. Torula granuloma of cervical spinal cord. *J. Neurosurg.*, 1951, *8*, 327–335.
12. Marshall, M., and Teed, R. W. Torula histo-

lytica meningo-encephalitis: further report. *Ann. Int. Med.*, 1951, *34*, 1277–1279.
13. MILLS, C. K., and SPILLER, W. G. Case of external spinal pachymeningitis implicating entire ventral surface of spinal dura. *Brain*, 1902, *25*, 318.
14. MINTZMAN, J. Case of epidural spinal abscess. *Brit. M. J.*, 1934, *2*, 593.
15. MIXTER, W. J., and SMITHWICK, R. H. Acute intraspinal epidural abscess. *New England J. Med.*, 1932, *207*, 127–131.
16. SCHMALZ, A. Ueber akute Pachymeningitis spinalis externa. *Virhows Arch. f. path. Anat.*, 1925, *257*, 521–560.
17. SHENKIN, H. A., HORN, R. C., JR., and GRANT, F. C. Lesions of spinal epidural space producing cord compression. *Arch. Surg.*, 1945, *51*, 125–146.
18. SLAUGHTER, R. F., FREMONT-SMITH, F., and MUNRO, D. Metastatic spinal epidural abscess; report of case with recovery following operation. *J.A.M.A.*, 1934, *102*, 1468–1470.
19. SPENCER, N. H. Case of idiopathic inflammation of spinal dura mater. *Lancet*, 1879, *1*, 836.
20. STAMMERS, F. A. R. Spinal epidural suppuration, with special reference to osteomyelitis of vertebrae. *Brit. J. Surg.*, 1938–1939, *26*, 366–374.
21. SUMNER, J. W., JR. Epidural abscess secondary to brucellosis ("Brucella suis"). *U. S. Armed Forces M. J.*, 1950, *1*, 218–221.

DISCUSSION

DR. GEORGE M. WYATT, Orangeburg, South Carolina. Dr. Campbell's paper is a timely one. As he has said, there is practically nothing in the roentgenological literature about the subject, and it is a condition of which every radiologist should be aware. It is well, therefore, to have this paper in the radiologist's library and to have had him read it.

Dr. Campbell implied in his text that about all he was doing was transferring what has been written in the neurosurgical literature into the radiological literature, but he has done a lot more than that. He has included detail of roentgenologic findings and differential points that you will not find in any surgical literature.

There is one thing about his paper that I would like to have him explain, and that is the use of the word "granuloma." I would call most of these cases "abscesses."

I also would like to know what the incidence of this lesion has been in his experience. In my experience it is rather rare.

There is one point which he probably should emphasize more than he did which is that these cases in many instances are emergencies. The difference between permanent paralysis and recovery may be a matter of only a few hours. In other words, when a case like this comes along, don't put it over until your next session of scheduled myelography.

I appreciate the opportunity of discussing this paper. Again I would like to say that I believe it is an important one, and timely.

DR. CAMPBELL (closing). Dr. Wyatt brought up a very good point regarding the terminology used. In our paper we mentioned the "so-called granulomas," and put that in quotation marks, because it seemed to us, too, that we had lesions varying from the liquid to the solid variety, and that any stage of development of an inflammatory mass within the confines of this neural canal could give a syndrome which would be indistinguishable from a roentgenological standpoint.

However, the neurosurgical literature continues to use the word "granuloma." It makes very little attempt to differentiate it clinically. We feel we have a nuerosurgical emergency on our hands, whether or not it is liquid or solid.

From a pathological standpoint we have an abscess, or we have an abscess plus granulation tissue, or we have a true infectious granuloma. I think the pathologists can make such differentiations. Certainly we can't from a roentgenological standpoint.

The fact remains, however, that the majority of the lesions producing this particular type of thing are the ones that tend to remain somewhat localized and confined, and make a space lesion of definite dimensions rather than simply a liquefying process that extends up and down the canal and into the other areas.

We have had 12 of these cases in the last six years, which would be an incidence of about 2 per year. I think it is important to take into account the type of patients you have to examine. In our patient population, I think there is probably a higher incidence of this condition than there would be in other forms of practice.

I agree also that this does constitute an emergency condition, and we feel very strongly that if there is any evidence of inflammatory change around the spine, in the presence of this type of pain, one had better consider myelography immediately, even in the middle of the night.

Vol. 72, No. 2

ROENTGENOGRAPHIC STUDIES OF OSTEOPOROSIS*

II. THE INHIBITIVE EFFECT OF DIETARY PHOSPHATE FERTILIZER ON DENTAL CARIES AND SKELETAL DECALCIFICATION IN THE RAT

By J. GERSHON-COHEN, M.D., *and* J. F. McCLENDON, Ph.D.

PHILADELPHIA, PENNSYLVANIA

THE addition of a phosphate fertilizer directly to the diet of an animal instead of indirectly through application to the soil poses some attractive possibilities. Among these is the correction of calcium, phosphorus and fluorine deficiencies which now account for a relatively high incidence of dental caries and osteoporosis in our population. This report concerns roentgen studies of rats on diets which are cariogenic without the addition of rock phosphate.

METHOD AND RESULTS

Wistar white rats were used in these experiments which were begun when the animals were twenty-one days of age. One half of each litter was given a cariogenic diet and the other half was given a similar diet except for additional varying amounts of Tennessee brown rock phosphate. Dental caries and calcification of the bones were determined by comparative roentgen studies of the jaws, teeth and skeleton.

The cariogenic diet (Diet I) consisted of 800 grams cracked yellow corn, 30 gm. alfalfa meal, 60 gm. linseed meal, 250 gm. sucrose, 80 gm. corn oil, 500 gm. active dry yeast and 10 gm. sodium chloride. Added to all the diets once weekly was 1 gm. of fresh liver.

The diets used for prevention of dental caries were similar to Diet I except for the addition of graded amounts of Tennessee brown rock phosphate.

Prevention of dental cariogenesis did not occur with concentrations of rock phosphate below 20 gm. A diet containing 34 gm. gave the most pronounced results (Diet II). At this concentration, corresponding to a fluorine content of 700 ppm, a marked retarding effect on dental cariogenesis was observed. Of 56 rats on Diet II, caries occurred in 19 lower molars, or 5 per cent, whereas of 105 rats on a cariogenic diet (Diet I), caries occurred in 382 molars, or 61 per cent. [3] The upper incisors of rats on Diet II showed considerable overgrowth and elongation. The enamel of all teeth, best seen in the incisors, was thicker and denser. Moreover, no decalcification was seen in the bones of the rats on Diet II such as occurred in those on Diet I (Fig. 1 and 2). Not only do the roentgenograms show the changes in the teeth and bones, but also the periodontoclasia and infection around the roots of the carious teeth.

DISCUSSION

The calcium, phosphorus and fluorine in rock phosphate are presumed to be the chief ingredients accounting for the prevention of dental caries and decalcification of the skeleton. The trace elements besides fluorine, such as manganese, copper, chromium, magnesium, strontium, zinc, vanadium, nickel and silver, which are present in the rock phosphate, might have important unrecognized effects. Since fluorine already has been proved to be a potent anticariogenic factor, it is presumed that it was the factor most responsible for the observed effects. In this fertilizer, it occurs in the form of fluorapatite and it is only slightly soluble. The resultant low absorption accounts for its low physiologic availability, and may explain why 700 ppm as in Diet II were required to produce a pronounced effect. Compared to a concentration in communal water supplies of 1–2 ppm of the soluble sodium salt of fluorine, which is regarded as optimum for human intake, the difference seems excessive. But fluoride as fluorapatite or calcium fluoride is far less soluble than the sodium salt and, in the rat, it must be present in relatively high concentrations to produce an observable effect. Miller[5] found that it required 500 ppm of calcium fluoride in the diet of a rat before a caries-resistant effect could be

* From the Albert Einstein Medical Center, Northern Division, Philadelphia, Pennsylvania.

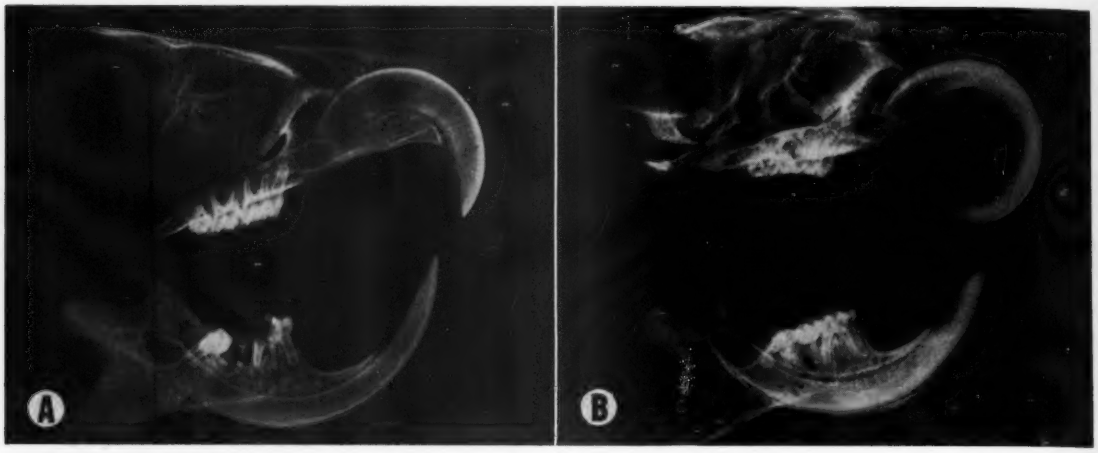


FIG. 1. (*A*) Extensive caries and periodontoclasia of lower molars in four month old rat on Diet 1. Jaw bones are poorly calcified. (*B*) Litter mate rat on diet containing rock phosphate; no caries is visible, upper incisors are overgrown and excellent calcification of bones is present.

detected. That such high concentrations of fluorine in the form of fluorapatite were not harmful but rather life sparing is attested to not only by the roentgen findings, but also by the fact that all the rats on Diet 1 died before seven months of age, while most of those on the diets with the higher supplements of rock phosphate showed no decrease in mortality rate. Moreover, the rats on the fertilizer diet maintained nor-

FIG. 2. (*A*) Rat on Diet 1 after three months; the skeleton is poorly calcified. (*B*) Litter mate rat on Diet 11; the skeleton is well calcified.

mal weights whereas the rats on the cariogenic diet lost weight progressively until death.

That factors other than fluorine have some related effect on dental changes would seem to be borne out by numerous observations concerning the relationship of malnutrition to dental caries. Massler and Schour,[4] in careful studies, implicated deficient calcium nutriture as the important factor in the causation of increased dental mottling. The failure to note signs of fluorosis in the rats receiving rock fertilizer may have been due to their better calcium nutriture because of the relatively high content of calcium and phosphorus in rock phosphate.

Studies in the human with diets containing rock phosphate already have been done. McClendon and Foster[2] determined dosage levels which could be taken without disturbing the balance of fluorine metabolism. With more studies of this type over sufficiently prolonged periods, the use of rock phosphate for direct consumption eventually might prove as beneficial in the human as in the rat.

In these experiments it was found that roentgenography lends itself well to the study of experimental dental caries and osteoporosis. Further improvements can be expected with the use of standardized photoelectric scanning and the use of proper photographic film and roentgenographic techniques.[1]

SUMMARY

The direct use of rock phosphate in the diet of the rat revealed roentgen evidence of retarded dental cariogenesis. In addition, prevention of skeletal decalcification and a life sparing effect were noted.

Roentgenography is an excellent aid in the study of experimental dental caries and osteoporosis in spite of its present limitations for this type of investigation.

J. Gershon-Cohen, M.D.
255 South 17th St.
Philadelphia 3, Pennsylvania

REFERENCES

1. Gershon-Cohen, J., and McClendon, J. F. Roentgenographic studies of osteoporosis. I. Replacement of common salt by balanced salt in diet of rats. *Radiology*, 1953, *61*, 261–265.
2. McClendon, J. F., and Foster, W. C. Prevention of dental caries by brushing teeth with powders containing fluorapatite. *J. Dent. Research*, 1947, *26*, 233–239.
3. McClendon, J. F., and Gershon-Cohen, J. Prevention of dental caries by rock phosphate in diet of rat. *Science*, 1953, *117*, 595–596.
4. Massler, M., and Schour, I. Relation of endemic dental fluorosis to malnutrition. *J. Am. Dent. A.*, 1952, *44*, 156–165.
5. Miller, B. F. Inhibition of experimental dental caries in rat by fluoride and iodoacetic acid. *Proc. Soc. Exper. Biol. & Med.*, 1938, *39*, 389–393.

MEDICAL ASPECTS OF HIGH ENERGY ELECTRON BEAMS*

By LEWIS L. HAAS, ROGER A. HARVEY, JOHN S. LAUGHLIN,† JOHN W. BEATTIE, *and* WALTER J. HENDERSON

From the Department of Radiology, College of Medicine, University of Illinois

CHICAGO, ILLINOIS

ELECTRON beams have been used in radiation therapy for a long time under such synonyms as cathode rays or beta radiation. Medical application has occurred in three periods:

1. *Low energies* produced by the low voltage of conventional roentgen-ray equipment, or from beta-ray applicators. Useful penetration is limited to less than 0.5 mm. and these sources can therefore only be used for very thin lesions of the skin or eye surface.

2. *Middle energies*, 1–6 mev., produced first by the 6 mev. betatron (Göttingen)[1,2,5,6,8] with a useful penetration of 2 cm. and later by the 2 mev. Van de Graaff accelerator (M. I. T., Cambridge)[10,11] with an effective therapeutic range of 7 mm.

3. *High energies*, 7–22 mev., produced by the betatron[9] and, to our knowledge, first applied for medical use at the University of Illinois College of Medicine in Chicago in March, 1951.[4,7] Useful penetration is at least 8 cm. at the upper energy level and may be exceeded by cross firing techniques. The range of energy available from this one machine affords specific flexibility of depth localization from surface lesions to those down to 8 cm. below the surface.

The production, dosimetry and physical aspects of the high energy electron radiation have been presented in an earlier paper from this department.[7] However, a few of the physical characteristics of the high energy electron beam should be repeated here in order to determine and evaluate indications and advantages of their medical application over other types of radiations.

1. Rather homogeneous absorption in tissues from the surface down to a certain depth.

2. Useful effective depth can be regulated by the voltage, up to 8 cm. from one portal at our energies.

3. The subsurface dose increase above 10 mev. is insignificant. Below 10 mev. it exceeds 10 per cent.

4. Rapid drop of intensity with insignificant absorption beneath the mentioned useful depth.

5. Further increase in voltage will result in a more gradual and prolonged zone of drop in intensity.

6. The difference between absorption in bone and soft tissue is less than with conventional roentgen rays.

The characteristic depth dose distribution of a 21.6 mev. electron beam is shown in Figure 1 and is compared with

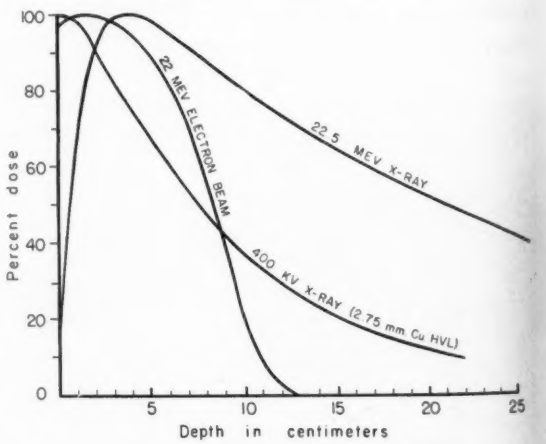


FIG. 1. Depth dose distribution of 22 mev. electron beam (12.5 cm. diameter field) compared with 400 kv. roentgen rays (half-value layer 2.75 mm. Cu, 100 cm²., 50 cm. target skin distance) and 23 mev. betatron roentgen rays (5 cm. diameter field, 80 cm. target skin distance).

* Presented at the Fifty-Fourth Annual Meeting, American Roentgen Ray Society, Cincinnati, Ohio, Sept. 29–Oct. 2, 1953.
† Now at Memorial Center, New York, New York.

TABLE I

DEPTH DISTRIBUTION

Comparison of Depth Distribution of High Energy Electron Beam, 23 mev. Roentgen-ray Beam of the Betatron, and 200 kv. Roentgen Rays

	Entrance	Maximum	Decrease	Exit	Back Scatter	Side Scatter	Relative Body/Tumor Volume Dose
200 kv. roentgen rays	Maximal	Skin	Gradual	Usually insignificant	Significant	Significant	High
23 mev. roentgen-ray betatron	Very low	at 4 cm. depth	Slow	High	Insignificant	Insignificant	Moderate
9–22 mev. high speed electron beam	Nearly maximal	Prolonged acme near to the surface	Steep	O	Moderate	Significantly increasing toward the depth	Very low (if lesion is adjacent to surface)

400 kv. roentgen-ray beam and with 23 mev. betatron roentgen rays. Table 1 also shows the difference in their depth distributions. Figure 2 shows a film which has been sandwiched in a phantom and exposed parallel to the electron beam.

The physical characteristics of high energy electron beams clearly indicate that it is most suitable for lesions which are located on the surface or near the surface. It is possible to reach lesions below 8 cm.

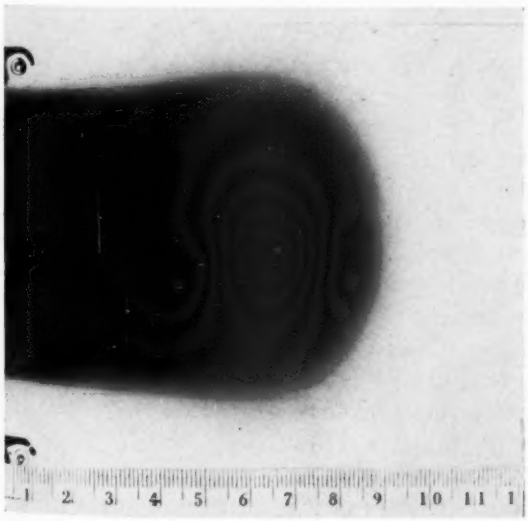


FIG. 2. Film exposed parallel to the electron beam; 17.3 mev. at 6 cm. diameter field. (Courtesy Radiology 60, 1953.)

effective depth if the surface is suitable for cross firing techniques or by further increases in voltage. However, the latter method introduces some disadvantages involving total volume doses, ratios of volume dose to tumor dose, and we might speculate on possible delayed rates of recovery and occurrence of general symptoms. Favorable sites of application are: skin; neck; groin; extremity; eye; parotid gland; maxillary antrum; oropharynx, including tonsil, hypopharynx, larynx; breast.

Specific types of lesions which are susceptible and suitable for electron beam therapy are the same ones which are commonly treated with conventional radiations. Indications thus far are that the generally accepted principle that every kind of radiation has the same qualitative biological effect also includes the electron beam. The Göttingen group[5] has reported some slight qualitative difference in biological effect experimentally. We have not repeated their experiments. Our own experiments and human experiences have not shown any difference in effect which could not be explained either by the different physical depth distribution or by the different quantitative effectiveness. Even if fine qualitative differences should exist, they have no great practical influence on

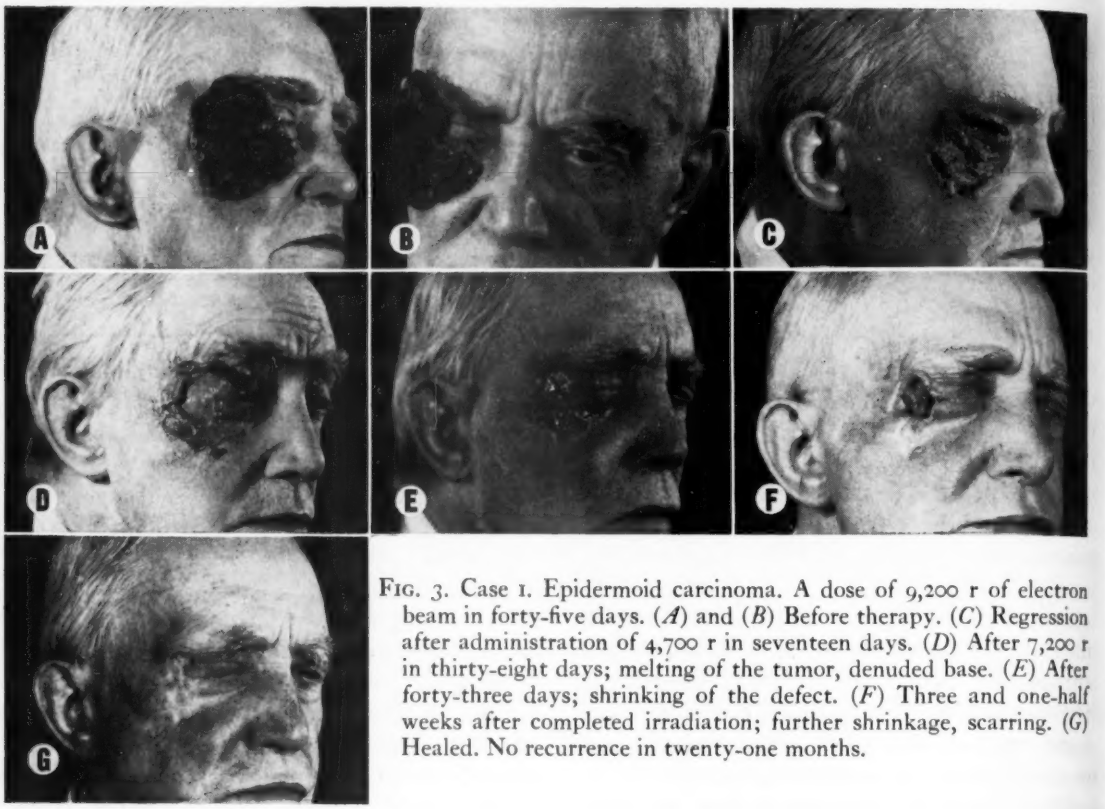


Fig. 3. Case 1. Epidermoid carcinoma. A dose of 9,200 r of electron beam in forty-five days. (*A*) and (*B*) Before therapy. (*C*) Regression after administration of 4,700 r in seventeen days. (*D*) After 7,200 r in thirty-eight days; melting of the tumor, denuded base. (*E*) After forty-three days; shrinking of the defect. (*F*) Three and one-half weeks after completed irradiation; further shrinkage, scarring. (*G*) Healed. No recurrence in twenty-one months.

the human therapeutic indications and techniques of application during the early phases of evaluation.

Our theoretical considerations and experimental observations concerning quantitative difference in biological effect have already been published.[3] The conclusion was that the biological effect of the high energy electron beam versus 200 kv. roentgen rays, measured and expressed in roentgens of the Victoreen chamber, is approximately 0.70 on human skin and tumor. This figure is slightly higher than that obtained for betatron roentgen rays. This means that 8,600 r of the electron beam is equivalent biologically to a tumor dose of 6,000 r of 400 kv. roentgen rays.

On the basis of physical considerations alone, we could assume that the high energy electron beam might result in the following advantages over conventional roentgen rays:

1. Homogeneous dosage in all layers of a lesion.
2. Insignificant exit dose beneath the lesion in healthy tissue.
3. Faster and better recovery of radiation reactions.
4. Low volume dose per tumor dose.
5. Less damage of tumor bed.
6. Fewer general symptoms.
7. Less bone and cartilage damage.

In actual application these advantages have been confirmed. To our best knowledge we had no precedent for medical application of high energy electron beams. Therefore, after preliminary experiments, very cautious treatment planning and close observation of the first cases were necessary in order to establish basic facts concerning dosage, treatment technique, and radiation effects and reactions, as referred to in part in our previous papers.[3,7] The present paper is limited to our medical experiences which involve a very small number of patients, 13 thus far. The reasons for the small number are threefold: first is a safety factor in that we did not

Fig. 4. Case II. Epidermoid carcinoma with qualities of sweat gland carcinoma. A dose of 9,200 r in fifty-one days. (*A*) Before irradiation. (*B*) Gradual regression. (*C*) Healed.

want to treat a large number of patients only to discover years later that our methods were wrong; second is the fact that our early model betatron does not permit simultaneous or even rapid interchange between use of the roentgen-ray and electron beam; and third is the pressure from patient referrals to take care of the deeper, life threatening cancers which require the roentgen-ray beam as opposed to the more superficial, more slowly progressing lesions which were suitable for the electron beam. The relatively long observation of two and one-half years since the first case was treated gives us the necessary reassurance to treat a large number of patients in a short time the next time we convert to the electron beam.

Fig. 5. Case III. Metastatic skin nodes of malignant melanoma. Irradiated with different dosage (see text).

High energy electron radiation is indicated for skin lesions the thickness of which exceeds, or at least approximates, 3 cm. Treating thinner lesions than 3 cm., the tumor bed would receive a higher dose than with the optimal middle energies.

Case I (Fig. 3*A*, *B*). Neglected cauliflower-like fungating papillomatous squamous cell carcinoma in the right paraorbital region, also covering a part of the eyelid. The tumor surface was black in color. A dose of 9,200 r was delivered in forty-five days, with unwanted interruptions for thirteen days. The initial voltage of 8.9 mev. on 7.5 cm. diameter field was decreased after regression of the lesion to 6.9 mev. and 6.5 cm. diameter field size. The tumor melted gradually (Fig. 3*C*, *D*).

The remaining skin defect re-epithelized slowly (Fig. 3*E*, *F*) and healed in two months after completion of therapy with skin atrophy and slight edema of the eyelid (Fig. 3*G*). The skin reaction consisted only of marked hyperemia around the lesion.

Case II. (Fig. 4*A-C*). State hospital patient. Round elevated flat ulcerated bloody mass on left forehead. Squamous cell carcinoma with qualities of sweat gland carcinoma. The lesion was fixed but roentgenograms showed no bone involvement. A dose of 9,200 r was delivered in fifty-one days, with an interruption for seventeen days because of winter transportation difficulties. The lesion regressed gradually after marked skin hyperemia and healed with smooth atrophic skin scar, fixed slightly to the base.

Case III. Metastases of malignant melanoma. Disseminated skin nodes of the left chest wall and tumor masses in the axillary, supraclavicular and inguinal grooves were very suitable for comparison of different doses of different radiations, as reported in a previous paper.[3]

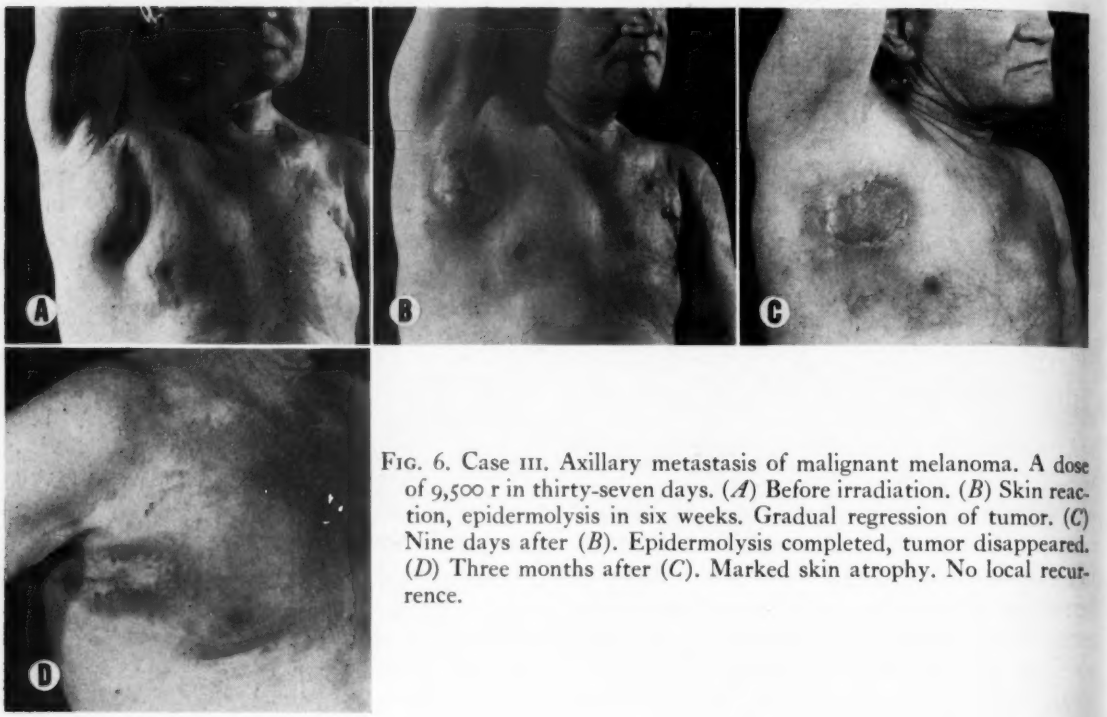


FIG. 6. Case III. Axillary metastasis of malignant melanoma. A dose of 9,500 r in thirty-seven days. (*A*) Before irradiation. (*B*) Skin reaction, epidermolysis in six weeks. Gradual regression of tumor. (*C*) Nine days after (*B*). Epidermolysis completed, tumor disappeared. (*D*) Three months after (*C*). Marked skin atrophy. No local recurrence.

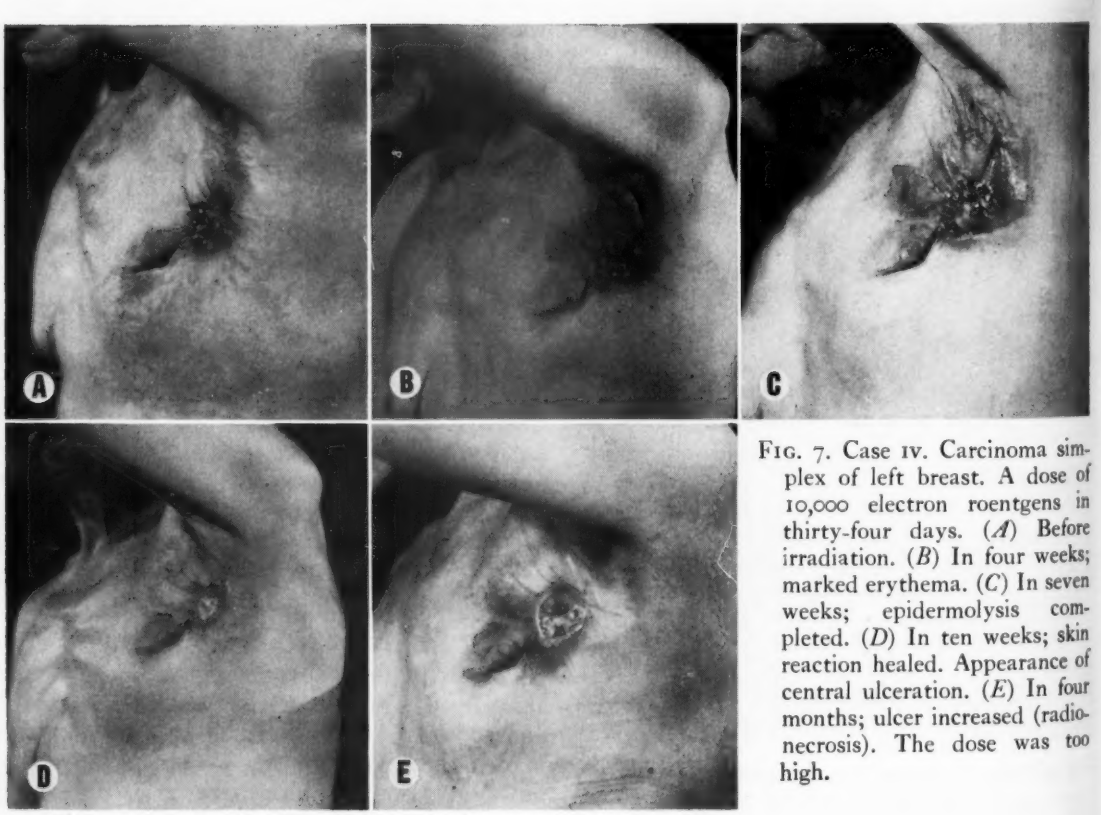


FIG. 7. Case IV. Carcinoma simplex of left breast. A dose of 10,000 electron roentgens in thirty-four days. (*A*) Before irradiation. (*B*) In four weeks; marked erythema. (*C*) In seven weeks; epidermolysis completed. (*D*) In ten weeks; skin reaction healed. Appearance of central ulceration. (*E*) In four months; ulcer increased (radionecrosis). The dose was too high.

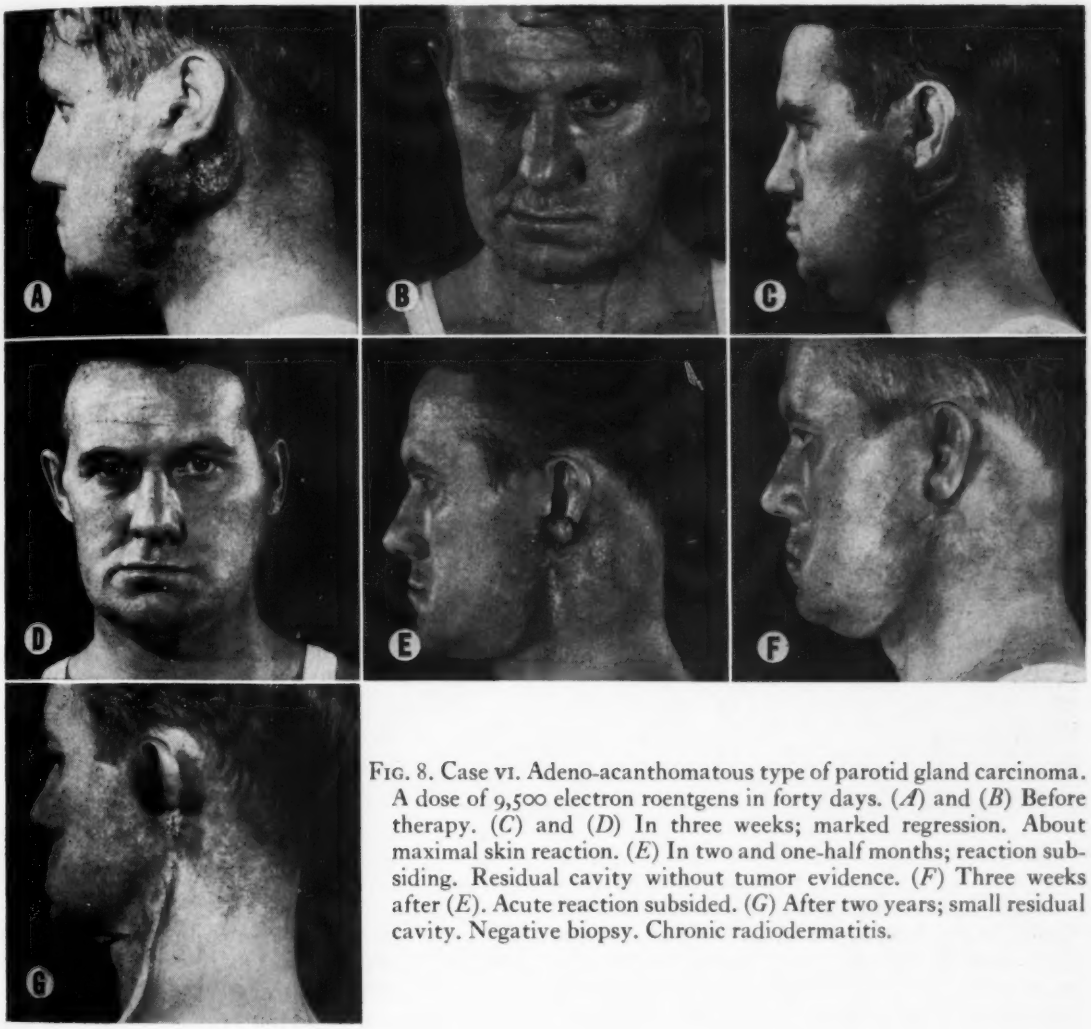


Fig. 8. Case vi. Adeno-acanthomatous type of parotid gland carcinoma. A dose of 9,500 electron roentgens in forty days. (*A*) and (*B*) Before therapy. (*C*) and (*D*) In three weeks; marked regression. About maximal skin reaction. (*E*) In two and one-half months; reaction subsiding. Residual cavity without tumor evidence. (*F*) Three weeks after (*E*). Acute reaction subsided. (*G*) After two years; small residual cavity. Negative biopsy. Chronic radiodermatitis.

1. Skin nodes. Figure 5 shows irradiated and nonirradiated nodes. The arrow (↑) marks intensive epidermolysis after 3,000 r single dose. Subsequently the skin healed. The nodes marked with arrows (⇄) received 2,000 and 2,500 r single doses respectively, and healed rapidly after moderate epidermolysis. There is residual pigmentation. The node (*X*) was irradiated with 1,600 r, healing after insignificant scaling of the epidermis. The other visible reactions were produced by other types of radiation.

2. Tumor mass of axillary glands (Fig. 6*A-D*), irradiated with 9,500 r of 17.2 mev. electron beam in thirty-seven days. (*A*) Before irradiation. (*B*) Gradual regression, increasing skin reaction. (*C*) and (*D*) Decrease of epidermolysis which healed in eleven weeks after last irradiation with skin atrophy. Tumor mass disappeared.

Case iv. Breast (Fig. 7*A-E*). Carcinoma simplex of the left breast. A dose of 10,000 r of 15.1 mev. electron beam was given in thirty-four days. Maximal skin reaction (epidermolysis) occurred eight days after the last treatment, followed by gradual regression. However, after eight weeks ulceration developed in center of the field (Fig. 7*D*) and slowly increased in size (radionecrosis) (Fig. 7*E*). The delivered dose was too high. Local tumor regression occurred, but progression outside of the field continued. Radical mastectomy followed.

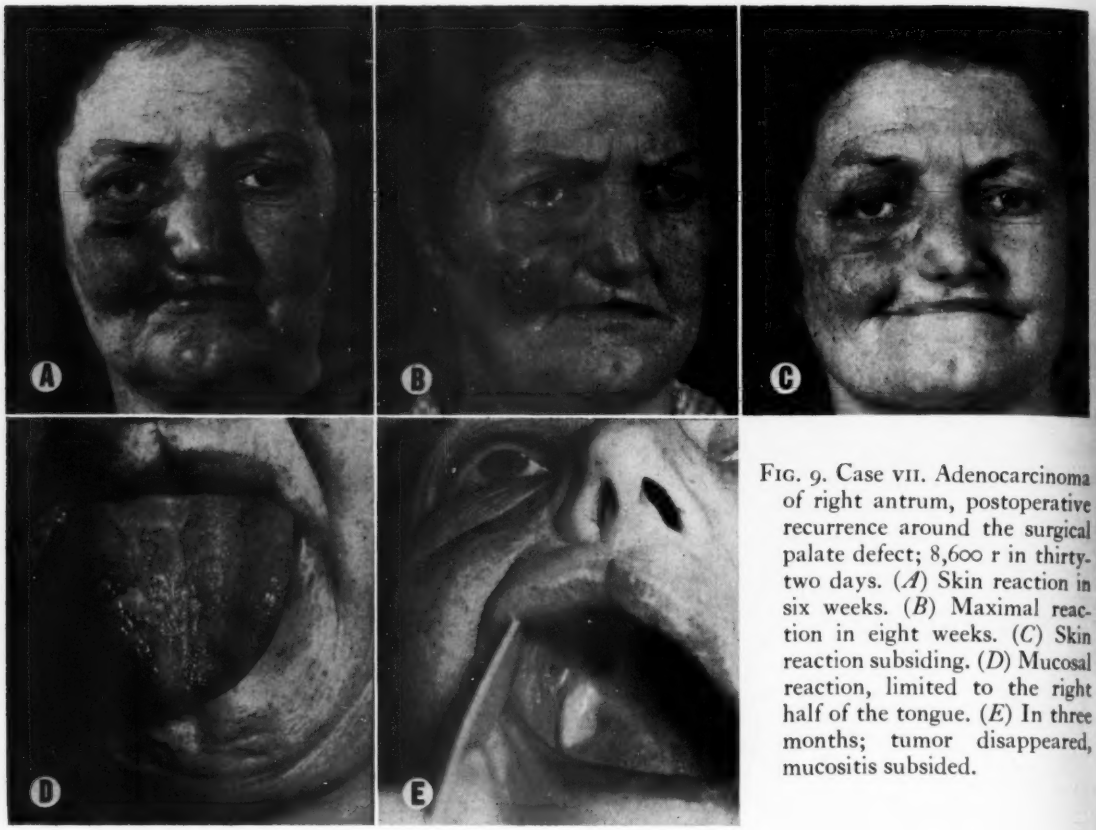


Fig. 9. Case vii. Adenocarcinoma of right antrum, postoperative recurrence around the surgical palate defect; 8,600 r in thirty-two days. (*A*) Skin reaction in six weeks. (*B*) Maximal reaction in eight weeks. (*C*) Skin reaction subsiding. (*D*) Mucosal reaction, limited to the right half of the tongue. (*E*) In three months; tumor disappeared, mucositis subsided.

Case v. Retinoblastoma. Bilateral advanced disease in a girl, aged two and a half years. Right bulb was enucleated but there was some residual tumor in the socket. Tumor mass was present in the left bulb. A dose of 6,700 r was given to the right eye, 7,700 r to the left of 8.9 mev. electron beam in eight and one-half weeks, but treatment was interrupted for four weeks for measles. The lesion regressed markedly with some remaining vision. However, after three months the lesion progressed again, with later loss of vision. It could not be influenced with 200 kv. roentgen rays, and the eye had to be enucleated. No tumor evidence could be found in the right eye socket.

Case vi. Parotid tumor (Fig. 8*A-G*). Carcinoma of adeno-acanthomatous type. A dose of 9,500 r at 15.1 mev. was given in forty days. Fast regression of the tumor resulted. A residual necrotic cavity remained on the site because of trophic conditions. The mastoid tip became denuded, and free in the cavity. The irradiated skin shows the signs of chronic radiodermatitis. Recently, two years after treatment, re-epithelization from the margins is in progress again; the cavity shows further decrease. Ten months after irradiation radical neck dissection had to be performed. Now nineteen months after the neck dissection, and twenty-nine months since the irradiation, there is no tumor evidence. Biopsy of the residual cavity was negative.

Case vii. Maxillary antrum (Fig. 9). Postsurgical recurrence of adenocarcinoma of the right antrum with fungating growth around the surgical window in the palate. A dose of 8,600 r of 17.3 mev., later 15.1 mev., electron beam was given in thirty-two days. At the time of completion of treatment, the tumor disappeared, and did not recur in the remaining life of the patient of eleven and one-half months. She died of metastases from her second carcinoma, *i.e.*, the breast. Figure 9*A*, *B* and *C* show the skin reactions, Figure 9*D* a moderate mucositis of the tongue. It is noteworthy that the latter was limited to the right half of the tongue, due to the sudden drop of beam inten-

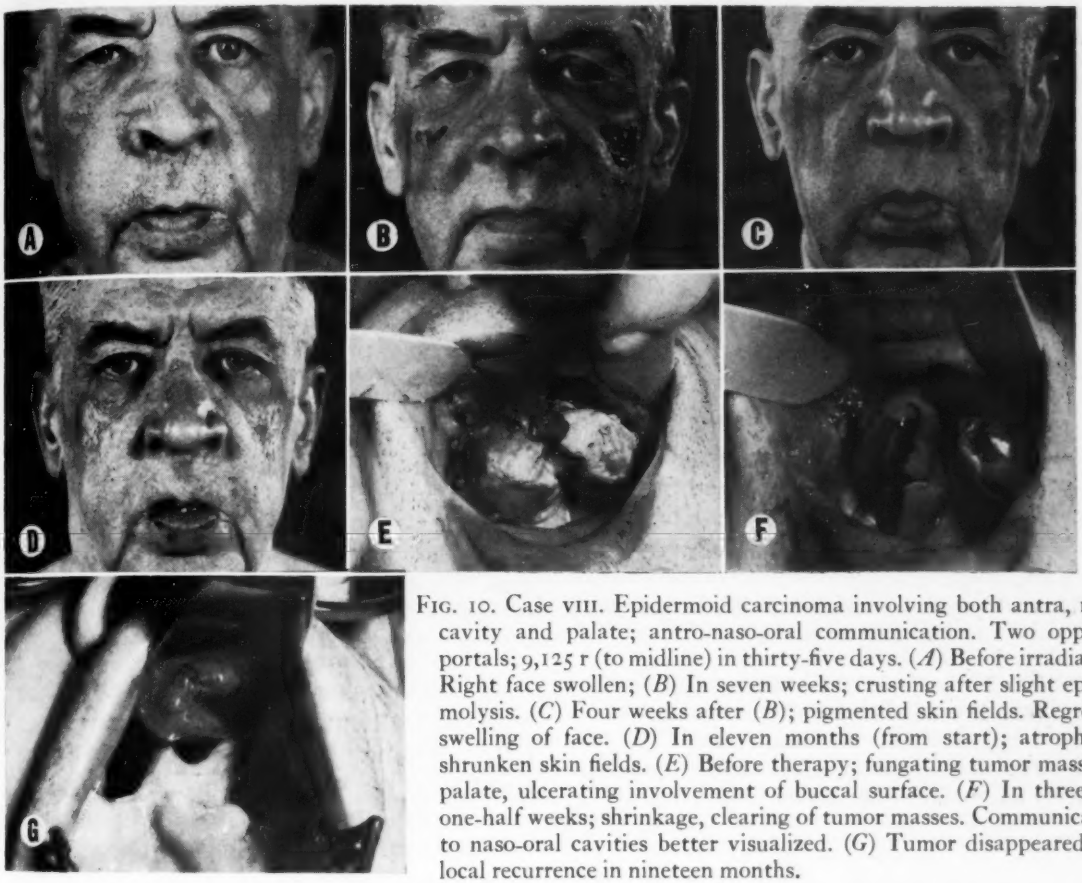


Fig. 10. Case VIII. Epidermoid carcinoma involving both antra, nasal cavity and palate; antro-naso-oral communication. Two opposite portals; 9,125 r (to midline) in thirty-five days. (*A*) Before irradiation. Right face swollen; (*B*) In seven weeks; crusting after slight epidermolysis. (*C*) Four weeks after (*B*); pigmented skin fields. Regressed swelling of face. (*D*) In eleven months (from start); atrophy of shrunken skin fields. (*E*) Before therapy; fungating tumor masses of palate, ulcerating involvement of buccal surface. (*F*) In three and one-half weeks; shrinkage, clearing of tumor masses. Communication to naso-oral cavities better visualized. (*G*) Tumor disappeared. No local recurrence in nineteen months.

sity (Fig. 9*D*). Figure 9*E* shows the healed tumor area where the reaction was rapid and subsided without visible trace.

Case VIII. Epidermoid carcinoma (Fig. 10*A–G*). Neglected case of epidermoid carcinoma, involving both maxillary antra, nasal cavity, soft and hard palate with infected fungating masses. Wide oro-vestibulo-naso-antral communication existed. The cheek is swollen and the right nasofacial crease is filled out. The source of the primary lesion is not certain. It is customary to place similar cases in the antral carcinoma group. The advanced destruction gave the impression of incurability. Experimental electron beam radiation was administered. The depth of the extensive lesion exceeded our useful 8 cm. limit, so two opposite fields were employed, resulting in an adequate isodose distribution with 17.3 mev. energy (Fig. 11). A 9,125 r tumor dose maximum was delivered in thirty-five days. The tumor gradually disappeared, the naso-oro-antral communication became wider (Fig. 10*F*) by breaking down of the tumor masses. A moderate epidermolysis healed with skin atrophy. The atrophic skin fields later decreased in size by shrinking. Now, nineteen months since irradiation, there is no sign of local recurrence. He has received dentures to improve his food intake and to restore the shape of the face. Ten months after irradiation neck nodes appeared, which were removed by radical neck dissection. There has been no evidence of neck nodes since then.

Case IX. Tonsil. Large firm undifferentiated carcinoma of the left tonsil, with rapidly growing metastatic masses of the neck (subauricular and supraclavicular).

The upper mass was included in the field of the tonsil. The lower mass had to be irradiated separately. A dose of 9,000 r of 17.6 mev. electron beam was delivered in thirty-seven days to the tonsil field. The same dose of 13.1 mev. was delivered to the lower mass. The primary lesion and neck metastases rapidly disappeared. Marked epidermolysis healed in two

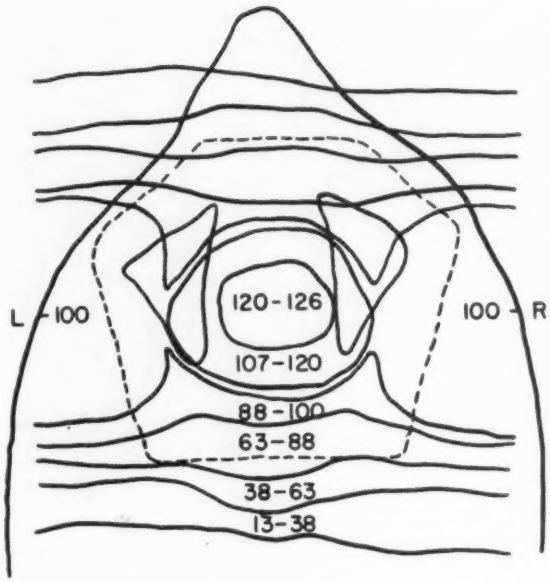


Fig. 11. Case viii. Isodose curve of the two portal electron dose distribution.

months, with moderate atrophy and marked depigmentation of the colored skin. It was remarkable that the marked mucositis in the pharynx was unilateral and subsided in a relatively short time—five weeks.

The patient worked and lived a normal life for eight months when he became incapacitated from generalized metastases and died eleven months after irradiation. Autopsy showed only scarring of the tonsil (Fig. 12), and no residual tumor cells could be found in the tonsil or in the neck. Generalized pulmonary and abdominal metastases were present, including paravertebral lymphatics and internal mammary chain, thus showing the way of invasion.

Fig. 12. Case ix. Undifferentiated carcinoma of left tonsil. Autopsy specimen. Scarred tonsil. No local recurrence in eleven and one-half months. Patient died of metastases.

Case x. Epidermoid carcinoma of the right glossopharyngeal sulcus. Large subauricular and supraclavicular neck node masses were present. An upper field included the primary lesion and the upper neck mass. A dose of 8,600 r of 17.3 mev. was delivered in thirty-three days. To the lower, smaller neck nodes, 7,000 r of 13.6 mev was delivered in twenty-two days. On completion of the irradiation the primary lesion disappeared. The neck nodes regressed markedly, however small residuals were palpable in both fields, which proved to be positive by biopsy. Neck dissection was planned, but four months after irradiation disseminating metastases appeared along with pleurisy and the patient died thirteen months after the irradiation. The terminal stage may have been prolonged by various experimental procedures.

SUMMARY

1. The number of patients treated with high energy electron beam (7–22 mev.) was until now small, but representative, and the curative effect has been very impressive.

2. The impression is that cancer annihilation with the electron beam excels: (a) by its reliably fast, yet gradual, even course which can be attributed to the rather homogeneous distribution of the beam in the tumor; (b) by the seemingly less damaging and faster recovery from the radiation reaction, which is also probably due to the different dose distribution. The tissue dose near the end of penetration of the beam falls off rapidly.

3. The skin reaction does not differ essentially from other radiations. The skin received about the same dose as the adjacent tumor tissues.

4. Qualitative differences in therapeutic biological cellular effect were not detected.

5. The biological effect of high energy electron beam on human skin, mucosa and tumor is approximately 0.70. That is, a tumor dose of about 8,600 r is equivalent to about 6,000 r of the 400 kv. radiation.

Lewis L. Haas, M. D.
808 South Wood St.
Chicago 12, Illinois

REFERENCES

1. Bode, H. G., Paul, W., and Schubert, G. Elektronentherapie menschlicher Hautkarcinome mit einem Betatron von 6 Millionen Elektronen-Volt. *Strahlentherapie*, 1950, *81*, 251–266.
2. Gund, K., and Wachsmann, F. Versuche mit 1,5 bis 5 MeV-Elektronen einer Elektronenschleuder. *Strahlentherapie*, 1948, *77*, 573–584.
3. Haas, L. L., Laughlin, J. S., and Harvey, R. A. Biological effectiveness of high speed electron beam in humans. Accepted for publication in *Radiology*.
4. Harvey, R. A., Haas, L. L., and Laughlin, J. S. Effects of x-ray and electron beam from betatron on head and neck cancer. Proceedings of Second National Cancer Conference, Cincinnati, 1952.
5. Kepp, R. K. Die Verwendung schneller Elektronen in der Strahlentherapie. *Radiol. Austriaca*, 1953, *6*, 213–233.
6. Kepp, R. K., Paul, W., Schmermund, H. J., and Schubert, G. Neue Methoden in der Behandlung der Vulvakarzinome. *Geburtsh. u. Frauenh.*, 1951, *11*, 298–312.
7. Laughlin, J. S., Ovadia, J., Beattie, J. W., Henderson, W. J., Harvey, R. A., and Haas, L. L. Some physical aspects of electron beam therapy. *Radiology*, 1953, *60*, 165–185.
8. Schubert, G. Die Elektronen-Therapie mit einem 6 Millionen Elektronenvolt-Betatron. *Wien. med. Wchnschr.*, 1950, *100*, 70–73.
9. Skaggs, L. S., Almy, G. M., Kerst, D. W., and Lanzl, L. H. Development of betatron for electron therapy, with introduction on therapeutic principles of fast electrons by E. M. Uhlmann. *Radiology*, 1948, *50*, 167–173.
10. Trump, J. G., Van de Graaff, R. J., and Cloud R. W. Cathode rays for radiation therapy. Am. J. Roentgenol. & Rad. Therapy, 1940, 1940, *43*, 728–734.
11. Trump, J. G., Wright, K. A., Evans, W. W., Anson, J. H., Hare, H. F., Fromer, J. L., Jacque, G., and Horne, K. W. High energy electrons for treatment of extensive superficial malignant lesions. Am. J. Roentgenol., Rad. Therapy & Nuclear Med., April, 1953, *69*, 623–629.

DISCUSSION

Dr. Hugh F. Hare, Los Angeles, California. The effect of electron therapy on tumor and normal tissue has been well presented by Dr. Haas. This is a new piece of work, and unless one has had experience with electron therapy it is difficult to discuss its value. However, it is shown conclusively that the deeper tissues are not involved in the radiation, and that the effect on the tumor is the same as that which is obtained with radium and roentgen therapy.

We should remember that the cases treated were all so-called hopeless ones, and the palliative results shown are excellent.

I should like to ask Dr. Haas if there is more scatter of electrons on bone than from roentgen or gamma radiation.

I wish to congratulate the authors on their fine presentation of an interesting piece of clinical research.

Dr. T. J. Wachowski, Chicago, Illinois. I am sorry Dr. Harvey is not here to speak about this work. I had the pleasure of seeing all these cases in the Tumor Clinic at the University of Illinois. Dr. Laughlin will certify that I urged the Physics Department to keep the betatron running on the raw electron beam rather than on the high voltage roentgen-ray beam because of the interest in this work.

I am certain that we can treat large flat localized lesions with a great deal more safety than we can with the orthodox low, intermediate or high voltage roentgen-ray beam. I think this work has great possibilities for the future, and I certainly think it should be continued and that the authors should start a new series of cases as soon as possible.

IRRADIATION OF LYMPHOID HYPERPLASIA OF THE NASOPHARYNX*

By ROBERT J. REEVES, M.D.
DURHAM, NORTH CAROLINA

THIS paper might appear superfluous in as much as the entire subject has been well covered by Garland and his associates,[5] but the increasing number of reports appearing in the nonradiological literature advocating the use of radium applicators indicates a failure to recognize the importance of roentgen therapy. Unfortunately, Crowe[1] and his co-workers did not recognize or employ this important method of treatment.

No attempt is made here to compare results obtainable by roentgen therapy with those obtainable by other methods. A comparative study of depth doses, however, will be reviewed again (Tables I and II); no attempt is made to tabulate all references in the literature.

INDICATIONS FOR ROENTGEN THERAPY

Roentgen therapy has been used satisfactorily for many years. As early as 1906, Dionisio[3] reported 20 cases treated by roentgen irradiation, the patients suffering from chronic suppurative inflammation of the middle ear. All were benefited and 16 cases were reported cured. Desjardins[2] reviewed the literature up to 1940 and found that roentgen therapy was most helpful in the treatment of the pharynx.

Since that time, especially during World War II, the use of intranasal radium has been popularized by the nonradiologist. The method was widely advocated for that special group of cases showing eustachian tube deafness. We have seen several instances of overtreatment. There are two types of applicators sold by the manufacturers but no physical information is included.

After reviewing our group of over 1,200 cases we find the largest group are those of both adults and children who have recurrent or persistent colds, with or without cough. In this group the patients may show varying degrees of colored nasal and postnasal drainage, with recurrent sore throats and followed by a cold. In some instances there may be decreased acuity of hearing, or even deafness. The pharynx usually contains lymphoid granulation tissue.

In another group, cough is the presenting symptom. It may be either with or without sore throat or cervical adenitis. These patients frequently give a history of postnasal drip with the cough greatest on arising in the morning. After the bronchi are cleared of this mucoid secretion, the cough is lessened. These patients usually show a diffuse lymphoid hyperplasia. The cough is frequently relieved after three or four roentgen treatments over the nasopharynx and at times over the tracheal region. In adults, where the tonsils have been removed and the treatment given over cloudy sinuses and pharyngeal areas, the results are usually favorable. Pain and soreness involving the tonsillar tags are always relieved by irradiation, making further surgical removal unnecessary.

In a third group, there are the asthmatics who notice a severity of symptoms with recurrent sore throats and colds. Often a striking diminution of the attacks is noted following irradiation.

A fourth group includes those persons with a systemic infection, such as the arthritics, who get an accentuation of symptoms with frequent colds. We believe the posterior pharynx may be considered a definite focus for systemic infection.

Patients with ear symptoms all were subjected to tonsillectomy and adenoidectomy. The recurrence of adenoids after

* From the Department of Radiology, Duke University Hospital, Durham, North Carolina. Presented at the Fifty-third Annual Meeting, American Roentgen Ray Society, Houston, Texas, Sept. 23–26, 1952.

surgery is so frequent that it may be regarded as normal. This recurrent adenoid tissue may maintain infection or become reinfected and impair the function of the eustachian tube, often leading to chronic progressive deafness. The infected adenoid nodules may be located in and around the eustachian tube but more often there is infection over the entire posterior pharynx. Patients suffering from this condition have otalgia, fullness in the ears, tinnitus and recurrent discharge, associated with varying degrees of deafness.

TREATMENT

The universal treatment of choice is radiation therapy. Roentgen rays may be used either externally, intraorally or there may be local application of radium. Roentgen therapy is the method of choice because of the distribution of the radiation and ease of application. Garland discusses the depth dose and distribution of radium and roentgen radiation (Table III) and there is no doubt that where lymphoid infection involves more than the eustachian tube region radium is of little value. Roentgen therapy can easily be given to children and the great advantage is that the entire pharynx is treated and no radiation damage has been found in our series (Fig. 1). The disadvantage of this method as given by some is that four to six treatments are given and, as Garland states, "The patient must go to a radiologist's office or hospital." The disadvantages of radium have been so thoroughly covered that they need not be repeated here.

FIG. 1. The rays are coned down and directed to the nasopharynx.

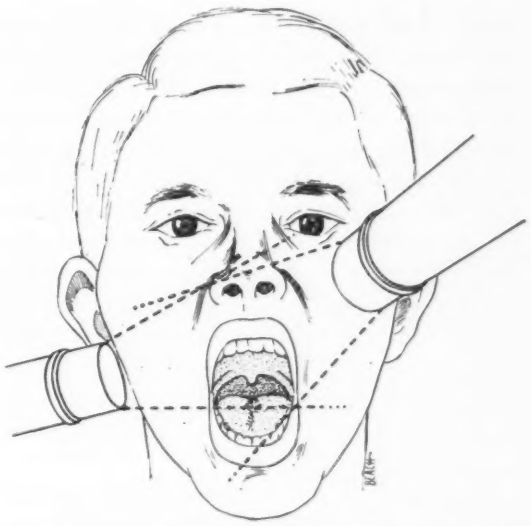


FIG. 2. The distribution of the radiation when directed through the angle of the mandible, toward the nasopharynx and also when directed through the maxillary antrum.

METHODS OF TREATMENT

In our former reports[4,6] we stated that we routinely gave four to six treatments to each side of the nasopharynx once weekly. The factors used at that time were 100 kv., constant potential, and 3 mm. aluminum filter. The first 468 cases were treated by this method. The results were fair but many had to have a repeat series. Since 1940 the routine has been 200 kv., with 0.5 mm. Cu and 1.0 mm. Al filter. The better

depth dose and more skin protection has cut down the number of cases requiring repeat series of treatments. The dosage consists of 100 r through a 4 by 6 cm. cone directed up beneath the eustachian tube toward the mid-pharynx (Fig. 2). After the first, the weekly treatments are increased to 150 r, for a total of 550 r to each side. Little intervening tissue is irradiated as the rays are directed up and behind the parotid gland, toward the nasopharynx. Portmann's method of directing the rays through the maxillary antra is also very good, especially where there is a low grade sinus infection (Fig. 2).

Of the group of 1,268 patients treated, they were roughly placed in four groups:

1. Frequent colds 721 cases; over 70 per cent showed marked improvement.
2. Postnasal drip due to nasopharyngeal infection 324 cases. All were relieved, 28 per cent completely and 72 per cent improved.
3. Impaired hearing thought to be attributable to focus of infection in the nasopharynx 38 cases; 75 per cent were relieved completely and 25 per cent improved.
4. Systemic infection, arthritis with definite lymphoid hyperplasia. Some of these cases were treated routinely, hoping to find a focus of infection, 129 cases.

SUMMARY

The value of roentgen therapy over radium is outlined. The homogeneous distribution of radiation is demonstrated. The recognition of this method of treatment should rest with the general practitioner and otolaryngologist. The importance of the impaired hearing should be constantly stressed. A series of 1,268 cases is difficult to evaluate completely but it shows the faith the otolaryngologist has in this method.

Duke University Hospital
Durham, North Carolina

REFERENCES

1. Crowe, S. J. Recognition, treatment and prevention of hearing impairment in children. *Laryngoscope*, 1940, *50*, 658–662; also, Irradiation of nasopharynx. *Ann. Otol., Rhin. & Laryng.*, 1946, *55*, 779–788.
2. Desjardins, A. U. Action of roentgen rays and radium on eye and ear. Am. J. Roentgenol. & Rad. Therapy, 1931, *26*, 643–679.
3. Dionisio, J. Abstract of "Traitement de l'otite moyenne suppurée chronique par les rayons x." *Arch. d'élect. méd.*, 1906, *14*, 934–938.
4. Eagle, W. W., and Reeves, R. J. Treatment of lymphoid hypertrophies and infections of pharynx and nasopharynx by irradiation. *South. M. J.*, 1936, *29*, 159–163.
5. Garland, L. H., Hill, H. A., Mottram, M. E., and Sisson, M. A. Nasopharyngeal irradiation. *J.A.M.A.*, 1951, *146*, 454–460.
6. Reeves, R. J. Radiation treatment of hypertrophied lymphoid tissue of pharynx and nasopharynx. Am. J. Roentgenol. & Rad. Therapy, 1937, *37*, 510–512.
7. Rossitto, A. F. Roentgen treatment of infections of lymphoid tissues in children. *Radiology*, 1947, *48*, 118–123.

DISCUSSION

Dr. David S. Beilin, Chicago, Illinois. The beneficial value of irradiation in the treatment of lymphoid hyperplasia of the nasopharynx is well known. External roentgen irradiation of the nasopharyngeal region has been universally accepted for many years with satisfactory results.

In common use is the radium applicator of monel metal containing 50 mg. of radium, giving 600 mg. min. of irradiation to each side.

The objective is to deliver an adequate and homogeneous distribution of radiation to the region involved. When the applicator is used it must be placed exactly on the lymphoid tissue since only tissue in its immediate vicinity receives adequate dosage. Too often the lymphoid hyperplasia is not limited so that the ionizing radiation is not adequate at regions remote from its source of application.

Radium must be used cautiously with precise knowledge as to dosage, complications, and possibility of late deleterious effects.

As Reeves has stated, roentgen therapy is the method of choice because of its simplicity of application and the better control of its distribution.

Vol. 72, No. 2

SOME OBSERVATIONS CONCERNED WITH CARCINOMA OF THE BREAST*

PART I

By MARLYN W. MILLER, M.D.,† *and* EUGENE P. PENDERGRASS, M.D.
PHILADELPHIA, PENNSYLVANIA

DURING the years 1923 to 1943, there were 1,034 patients with carcinoma of the breast seen at the Hospital of the University of Pennsylvania. Some of these cases have been considered from a radiologic standpoint in previous publications.[3,4,5] The present report includes the gross statistics of survival of 1,029 of these patients when treated by the general methods of operation alone, operation plus irradiation, and irradiation alone. In this presentation, no effort is made to evaluate preoperative or postoperative irradiation, or the effect of irradiation on recurrences and metastases. However, this report will include an analysis of tumor dosage in primary irradiation of the breast. Also, the relative positions of operation and irradiation in carcinoma of the breast in this series of cases will be referred to, but a detailed analysis of radiologic methods combined with surgery and the influence of surgical methods will be considered in subsequent reports.

METHODS OF STUDY

This study was a combined project of the Departments of Surgery, Surgical Pathology, and Radiology. The information secured from a review of the case histories of patients with carcinoma of the breast was tabulated on a questionnaire, which for each patient contained 131 major headings and 9 to 11 subdivisions under each major heading. The radiologic portion of the survey contained a calculation of the tissue or tumor dose for each portion of the body treated by radiation. After the data had been collected on the questionnaires, they were then transferred to International Business Machine (I.B.M.) code or punch cards and the latter were used to prepare the statistics for this report.

The whole series of 1,034 patients had a 78.8 per cent five-year follow-up,‡ and the hospital records were in enough detail to permit classification in 1,029 cases. Yet, in calculating tumor dosage it was found that two difficulties were prominent: (1) it was discovered that in the earlier years of the period covered (1923 to 1943), the physical factors of radiation were recorded in milliampere-minutes, but during the transitional period between the use of milliampere-minutes as a unit and the adoption of the roentgen as a unit, it was observed that both were recorded on charts, thus permitting a calculation of the early physical data in roentgens; (2) it was hard to determine the size of the breast, axilla, supraclavicular region, etc., of patients, inasmuch as such measurements were seldom recorded in the years when tissue or tumor doses were not figured. This latter difficulty was overcome in part by our measuring a number of patients being currently treated and then assuming an average distance from the skin to tumor or metastasis for each region of the body so treated; *e.g.*, breast 6 cm. to tumor, supraclavicular region 5 cm. from skin to lymph nodes, etc. This procedure allowed us to use depth-

‡ There were 220 patients of the 1,034 whose survival or nonsurvival was unknown. For statistical purposes they are counted as dead, but Tables II and III are constructed in such a way that limits of five year survival rates may be computed on the basis of two assumptions: (a) that all unknowns—died (the basis actually used); (b) that all unknowns—lived. The true survival rate obviously falls somewhere between these two limits.

* From the Department of Radiology, Hospital of the University of Pennsylvania, Philadelphia, Pennsylvania, and the Penn Mutual Life Insurance Foundation for the Study of Neoplastic Diseases. This work is carried on as a part of the program of the Institutional Grant of the American Cancer Society.

† Thesis submitted to the Faculty of Graduate School of Medicine of the University of Pennsylvania, toward the requirements for the degree of Master of Medical Science (M.Sc.Med.) for graduate work in radiology.

dose tables and thus to determine the average tissue dose.

CLASSIFICATION OF CASES

Although the primary purpose of this survey was to evaluate the experience of the Hospital of the University of Pennsylvania in the management of carcinoma of the breast, it was realized that such an appraisal could be done properly only by the use of standard or commonly used classifications in statistical studies for primary cases of carcinoma of the breast based on both clinical and pathologic criteria. It was therefore decided to utilize the four group or stage clinical classification of Portmann,[6]* the five stage classification of Richards,[7]† which is a modification of the one originally suggested by Portmann, and the Clinical Index of Malignancy given by Richards.[7]‡

There were too few cases in our group to make a significant correlation between the pathologic type, tissue dose of radiation and survival rate.

TECHNIQUE OF RADIATION THERAPY

During the years 1923 to 1943 there were thirty different routines of radiation therapy for carcinoma of the breast being used at the Hospital of the University of Pennsylvania. These routines represented various combinations of primary irradiation to the breast, preoperative or postoperative irradiation, preoperative or postoperative prophylactic castration, preoperative or postoperative prophylactic irradiation, postoperative irradiation, irradiation for recurrences and metastases, and castration for recurrences and metastases. The number of cases falling in any one category was therefore relatively small. Aside from these thirty different routines, the tissue dose of radiation in any one of them varied depending upon the patient, the stage of disease, response to treatment, general condition of the patient, etc.

TYPE OF TREATMENT GIVEN

The type of treatment given to patients with carcinoma of the breast originally treated at the Hospital of the University of Pennsylvania, and to patients previously treated elsewhere before coming to our hospital, is summarized in Table 1. It will be noted in this table that, of the total 1,034 cases in our series, 35.0 per cent had operation only; 53.9 per cent had operation plus irradiation; 35.0 per cent had irradiation only.

COMPARISON BETWEEN OPERATION, OPERATION PLUS IRRADIATION, AND IRRADIATION ALONE

The grouping or staging of our 1,029 cases of carcinoma of the breast in the series, available for complete study, in terms of Portmann's Clinical Classification and Richards' Stage of Disease Classifica-

* Portmann's Classification for Primary Cases of Cancer of Breast Based on Clinical and Pathologic Criteria—proposed for statistical reviews and as a basis for determining the indications for different methods of treatment.

Group or Stage I—Skin—not involved. Tumor—localized in breast and movable. Metastases—none in axillary lymph nodes or elsewhere.

Group or Stage II—Skin—not involved. Tumor—localized in breast and movable. Metastases—few axillary lymph nodes involved, no other metastases.

Group or Stage III—Skin-edematous; brawny red induration and inflammation not obviously due to infection; extensive ulceration; multiple secondary nodules. Tumor—diffusely infiltrating breast; fixation of tumor or breast to chest wall; edema of breast, secondary tumors. Metastases—many axillary lymph nodes involved or fixed; no clinical or roentgenologic evidences of distant metastases.

Group or Stage IV—Skin—as in any other group or stage. Tumor—as in any other group or stage. Metastases—axillary and supraclavicular lymph nodes extensively involved, and clinical or roentgenologic evidence of more distant metastases.

† Richards' Mammary Carcinoma Classification by Stage of Disease. (Richards' classification is a modification of one originally suggested by Portmann (July, 1943).

Stage I—Skin—not involved. Tumor—localized in breast, movable, 1–3 cm. in diameter. Metastases—none in axillary lymph nodes or elsewhere.

Stage II—Skin—not involved. Tumor—localized in breast, movable, 3–6 cm. in diameter. Metastases—few axillary lymph nodes involved; no other metastases.

Stage III—Skin—attached, dimpled, but not obviously invaded; or nipple retraction. Tumor—localized in breast; more than 6 cm. in diameter; attached to fascia but not fixed to chest wall. Metastases—few axillary lymph nodes may be present or the axillary lymph nodes may not be involved.

Stage IV—Skin—edematous or brawny induration or peau d'orange, or ulceration or local skin nodules or evidence of acute inflammation. Tumor—diffuse infiltration or rigid fixation to chest wall or edema of breast. Metastases—many axillary lymph nodes may be involved or fixed; no clinical or roentgenologic evidences of distant metastases.

Stage V—Skin—as in any other group or stage or with secondary nodules beyond the periphery of the breast. Tumor—as in any other stage or group. Metastases—extensive axillary lymph node involvement, or supraclavicular lymph nodes involvement, or clinical or roentgenologic evidences of distant metastases.

‡ Richards' table of Clinical Index of Malignancy of Carcinoma of Breast will be given in a subsequent report.

TABLE I

DISTRIBUTION OF CARCINOMA OF BREAST CASES SEEN AT HOSPITAL OF UNIVERSITY OF PENNSYLVANIA 1923–1943 BY THERAPY AND BY ORIGINAL PLACE OF TREATMENT

Therapy	Previously Treated Elsewhere	Original Treatment at Univ. of Pa.	Total	Percentage of Grand Total	Percentage of Total Available for Study
TOTAL	*223*	*811*	*1,034*	*100.0*	
Refused operation or failed to return	0	3	3	0.3	
Chemotherapy	0	1	1	0.1	
Therapy unknown	1	0	1	0.1	
TOTAL AVAILABLE FOR STUDY	*222*	*807*	*1,029*	*99.5*	*100.0*
Operation only	29	333	362	35.0	35.2
Irradiation and operation combined	185	372	557	53.9	54.1
Irradiation only	8	102	110	10.6	10.7
Irradiation only					*100.0*
For recurrences and metastases			17	1.6	15.5
Primary irradiation to breast only			93	9.0	84.5
					100.0
Tumor dose not codable			3	0.3	3.2
Tumor dose codable			90	8.7	96.8

tion is presented in Tables II and III respectively. These tables show survival incidence for patients actually treated, but the gross survival statistics do not show all the factors involved. The statistics by themselves are meaningless for they must be interpreted in the light of what is reasonable and in the light of a knowledge of the life history of carcinoma of the breast. As separate reports from our Department of Surgery will show, there were various surgical techniques employed by numerous surgeons during the period 1923 to 1943. Likewise, the Department of Surgical Pathology records will demonstrate that there was a great variation in the type of tumor encountered. Finally, this and other reports from the Department of Radiology will

TABLE II

NUMBER AND PERCENTAGE OF 5 YEAR SURVIVALS BY PORTMANN'S CLINICAL CLASSIFICATION AND BY TYPE OF THERAPY (CARCINOMA OF BREAST)

Classification / Group	Total Cases	Operation Only			Operation Plus Irradiation			Irradiation Only			Percentage Survival All Therapies	Survival or Nonsurvival Unknown (Considered as *dead*)			
		Total No.	Survival		Total No.	Survival		Total No.	Survival			Total No.	Oper. Only	Oper. Plus Irradiation	Irradiation
			5 yr.	Per Cent		5 yr.	Per Cent		5 yr.	Per Cent					
I	490	212	148	69.8	267	114	42.7	11	2	18.2	53.8	48	27	19	2
II	290	90	24	26.7	177	47	26.6	23	3	13.0	25.5	47	17	21	9
III	95	25	7	28.0	55	12	21.8	15	1	6.7	21.0	34	11	15	8
IV	115	23	1	4.3	33	2	6.1	59	0	0.0	2.6	76	21	15	40
Unclassified	39	12	0	0.0	25	5	20.0	2	0	0.0	12.8	15	9	4	2
TOTAL	1,029	362	180	49.7	557	180	32.3	110	6	5.4	35.5	220	85	74	61

TABLE III

NUMBER AND PERCENTAGE OF 5 YEAR SURVIVALS BY RICHARDS' STAGE OF DISEASE CLASSIFICATION AND BY TYPE OF THERAPY (CARCINOMA OF BREAST)

Classification / Stage	Total Cases	Operation Only			Operation Plus Irradiation			Irradiation Only			Percentage Survival All Therapies	Survival or Nonsurvival Unknown (Considered as *dead*)			
		Total No.	Survival 5 yr.	Survival Per Cent	Total No.	Survival 5 yr.	Survival Per Cent	Total No.	Survival 5 yr.	Survival Per Cent		Total No.	Oper. Only	Oper. Plus Irradiation	Irradiation
I	122	66	58	87.9	54	37	68.5	2	1	50.0	78.7	6	3	2	1
II	170	55	30	54.5	114	51	44.7	1	0	0.0	47.6	11	5	5	1
III	314	128	71	55.5	176	59	33.5	10	3	30.0	42.3	30	14	14	2
IV	244	71	20	28.2	141	27	19.1	32	2	6.2	20.0	67	27	29	11
V	137	28	1	3.6	46	2	4.3	63	0	0.0	2.2	95	27	22	46
Unclassified	42	14	0	0.0	26	4	15.3	2	0	0.0	9.3	11	9	2	0
TOTAL	1,029	362	180	49.7	557	180	32.3	110	6	5.4	35.5	220	85	74	61

show that the general term "irradiation" embraces many different routines of treatment applied to patients in differing stages of disease.

The 1,029 cases presented in Tables II and III were classified by a single member of our team (the surgical member), according to Portmann's and Richards' classifications, respectively; thus, it is believed that these figures are as reliable as they can be under the circumstances.

In interpreting the gross statistics one should know that:

1. The majority of the patients treated by operation were early cases.

2. Except for Group IV Portmann, or Stage V Richards (where there is a gain of 1.8 or 0.7 percentage points respectively by the use of irradiation with operation), there is a group by group or stage by stage less five year survival for irradiation combined with operation, than for operation alone. The over-all figures show: 32.3 per cent five year survival with operation and irradiation as compared to 49.7 per cent five year survival with operation alone. These observations are just the opposite of what Portmann and Richards indicate in their reports. They believe that irradiation when combined with operation adds to five year survival (with Portmann—Groups II, III, and IV, and with Richards—all stages). We are unable to explain the difference between their conclusions and ours.

TABLE IV

NUMBER AND PERCENTAGE OF 5 YEAR SURVIVALS BY PORTMANN'S CLINICAL CLASSIFICATION BY TYPE OF THERAPY WITH COMPARISON BETWEEN SIMPLE MASTECTOMY AND RADICAL MASTECTOMY (CARCINOMA OF BREAST)

Classification / Group	Total Cases	Operation Only									Operation plus Irradiation									Irradiation Only		
		Simple mastectomy			Radical mastectomy			Unclassified mastectomy			Simple mastectomy			Radical mastectomy			Unclassified mastectomy			Total No.	Survival	
		Total No.	Survival 5 yr.	Survival Per cent	Total No.	Survival 5 yr.	Survival Per cent	Total No.	Survival 5 yr.	Survival Per cent	Total No.	Survival 5 yr.	Survival Per cent	Total No.	Survival 5 yr.	Survival Per cent	Total No.	Survival 5 yr.	Survival Per cent		5 yr.	Per cent
I	490	93	60	64	117	86	73	2	2	100	105	47	45	154	65	42	8	2	25	11	2	18
II	290	25	4	16	64	20	31	1	0	0	50	13	26	123	32	26	4	2	50	23	3	13
III	95	7	1	14	17	6	35	1	0	0	19	3	15	34	7	20	2	2	100	15	1	7
IV	115	22	0	0	1	1	100	0	0	0	18	0	0	15	2	13	0	0	0	59	0	0
Unclassified	39	5	0	0	2	0	0	5	0	0	6	1	16	15	4	26	4	0	0	2	0	0
TOTAL	1,029	152	65	43	201	113	56	9	2	22	198	64	32	341	110	32	18	6	33	110	6	5.4

TABLE V

NUMBER AND PERCENTAGE OF 5 YEAR SURVIVALS BY RICHARDS' STAGE OF DISEASE CLASSIFICATION BY TYPE OF THERAPY WITH COMPARISON BETWEEN SIMPLE MASTECTOMY AND RADICAL MASTECTOMY (CARCINOMA OF BREAST)

Classification / Stage	Total Cases	Operation Only									Operation plus Irradiation									Irradiation Only		
		Simple mastectomy			Radical mastectomy			Unclassified mastectomy			Simple mastectomy			Radical mastectomy			Unclassified mastectomy			Total No.	Survival	
		Total No.	Survival 5 yr.	Survival Per cent	Total No.	Survival 5 yr.	Survival Per cent	Total No.	Survival 5 yr.	Survival Per cent	Total No.	Survival 5 yr.	Survival Per cent	Total No.	Survival 5 yr.	Survival Per cent	Total No.	Survival 5 yr.	Survival Per cent		5 yr.	Per cent
I	122	27	21	77	37	35	94	2	2	100	22	15	68	32	22	68	0	0	0	2	1	50
II	170	17	8	47	38	22	57	0	0	0	37	15	40	74	34	46	3	2	66	1	0	0
III	314	48	26	54	80	45	56	0	0	0	65	25	38	108	32	29	3	2	66	10	3	30
IV	244	31	9	29	37	11	29	3	0	0	41	9	22	97	18	18	3	0	0	32	2	6
V	137	23	1	4	5	0	0	0	0	0	26	0	0	19	2	10	1	0	0	63	0	0
Unclassified	42	6	0	0	4	0	0	4	0	0	7	0	0	11	2	18	8	2	25	2	0	0
TOTAL	1,029	152	65	43	201	113	56	9	2	22	198	64	32	341	110	32	18	6	33	110	6	5.4

COMPARISON BETWEEN SIMPLE MASTECTOMY AND RADICAL MASTECTOMY

The material presented in Tables II and III has been further subdivided in Tables IV, V, and VI, so as to give data on the results of simple and radical mastectomy in terms of five year survival and in terms of local recurrence after the respective operation.

SURVIVAL RATES ACCORDING TO COLOR OF PATIENTS AND FIVE YEAR PERIODS OF STUDY

Data given in Table VII show the five-year survival rates and percentages of survival according to the color of the patient and type of therapy; Table VIII classifies the patients by five year periods of study, type of therapy and five year survival.

TUMOR DOSAGE IN PRIMARY IRRADIATION OF THE BREAST

An analysis of the use of primary irradiation to the breast in terms of disappearance of local tumor and five year survival is given in Tables IX, X, and XI.

It is worth mentioning that of the 110 patients in both Portmann's and Richards' classifications (Tables II, III, IV, V, VII and VIII), who were listed under the title "irradiation alone," there were 17 who received irradiation for metastases only, thus leaving 93 under "primary irradiation to the breast." Ninety of the 93 were codable so far as calculation of tumor dose was concerned.

Tables IX, X, and XI demonstrate that out of these 90 coded patients receiving primary irradiation to the breast, 87 were in Stages III, IV, and V (Richards) and 62 were in Groups III and IV (Portmann). The tables show that 6 of the 90 patients secured a disappearance of tumor with irradiation and 5 of the 90 survived five years.

In Table XI, it will be noted that 12 of the 90 patients received 4,000 to 4,999 r tumor dose, 2 of these received that dosage within or less than one month, and the other 10 received the radiation over a period of one month to over one year. There were 3 additional patients who each received a 5,000 r tumor dose or more, delivered in three months to one year. The study of the effect of disappearance of the tumor with relation to tumor dose was not very informative.

In this study of primary irradiation of the breast for carcinoma, our results during the period 1923 to 1943 do not compare favorably with the reports from other clinics. Lenz[2] in 1946 stated: "the administration of a tumor dose of 5,500 r or more within three months has caused the clinical disappearance of the breast tumor and en-

TABLE VI

NUMBER AND PERCENTAGE OF LOCAL RECURRENCES AFTER SIMPLE MASTECTOMY AND AFTER RADICAL MASTECTOMY (CARCINOMA OF BREAST)

	Operation Only						Operation plus Irradiation					
	Simple mastectomy		Radical mastectomy		Unclassified mastectomy		Simple mastectomy		Radical mastectomy		Unclassified mastectomy	
	Cases	Per Cent	Cases	Per Cent	Cases	Per Cent	Cases	Per Cent	Cases	Per Cent	Cases	Per Cent
No local recurrences	53	34.9	117	58.2	4	44.4	63	31.8	144	42.2	4	22.2
Local recurrences	56	36.8	39	19.4	2	22.2	115	58.0	183	53.6	11	61.1
Condition of operative field unknown	43	28.3	45	22.3	3	33.3	20	10.1	14	4.1	3	16.6
TOTAL	152	100.0	201	100.0	9	100.0	198	100.0	341	100.0	18	100.0

TABLE VII

NUMBER AND PERCENTAGE OF 5 YEAR SURVIVAL WHEN PATIENTS ARE CLASSIFIED BY COLOR AND BY TYPE OF THERAPY (CARCINOMA OF BREAST)

Color	Total Cases	Operation Only			Operation plus Irradiation			Irradiation Only		
		Number	Survival		Number	Survival		Number	Survival	
			5 yr.	Per Cent		5 yr.	Per Cent		5 yr.	Per Cent
Black	81	30	12	40.0	42	15	35.0	9	0	0.0
White	931	326	168	51.0	504	165	32.0	101	6	5.9
Not coded	17	6	0	0.0	11	0	0.0	0	0	0.0
TOTAL	1,029	362	180	49.7	557	180	32.3	110	6	5.4

TABLE VIII

CLASSIFICATION OF CASES BY 5 YEAR PERIODS OF STUDY, BY TYPE OF THERAPY AND BY 5 YEAR SURVIVAL (CARCINOMA OF BREAST)

Periods (years)	Total Cases	Operation Only			Operation plus Irradiation			Irradiation Only		
		Number	Survival		Number	Survival		Number	Survival	
			5 yr.	Per Cent		5 yr.	Per Cent		5 yr.	Per Cent
1923–1927	193	56	18	32.0	114	35	30.0	23	1	4.3
1928–1932	245	69	26	37.0	152	42	27.0	24	3	12.5
1933–1937	252	71	36	50.7	151	54	35.0	30	1	3.3
1938–1942	339	166	100	60.0	140	49	35.0	33	1	3.0
TOTAL	1,029	362	180	49.7	557	180	32.3	110	6	5.4

TABLE IX

TUMOR DOSAGE IN PRIMARY IRRADIATION OF THE BREAST WITH CASES CLASSIFIED BY PORTMANN'S CLINICAL CLASSIFICATION; RESULTS INDICATED BY DISAPPEARANCE OF TUMOR AND BY 5 YEAR SURVIVAL (CARCINOMA OF BREAST)

Tumor Dose to Breast	Total No. of Cases	Group I			Group II			Group III			Group IV			Result (Totals)	
		No.	D*	5*	No.	D	5	No.	D	5	No.	D	5	D	5
50– 499 r	12	1	0	0	0	0	0	1	0	0	10	0	0	0	0
500–1,499 r	24	4	0	1	8	2	0	0	0	0	12	1	0	3	1
1,500–2,999 r	20	1	0	1	2	0	0	3	1	0	14	0	0	1	1
3,000–3,999 r	19	0	0	0	5	0	1	8	1	0	6	0	0	1	1
4,000–4,999 r	12	2	0	0	4	1	2	2	0	0	4	0	0	1	2
5,000 r and over	3	1	0	0	0	0	0	1	0	0	1	0	0	0	0
TOTAL	90†	9	0	2	19	3	3	15	2	0	47	1	0	6	5

* D—indicates disappearance of tumor; 5 indicates 5 year survival.
† Three additional cases not codable as to calculation of tumor dose.

larged axillary lymph nodes in 24 of 32 patients (1 treated in 1937)." Ten of these 24 cases, though inoperable, whose disease appeared limited to the breast and axillary lymph nodes, were free from clinical evidence of cancer five years after roentgen therapy. Richards[7] states that the average dose delivered throughout the tumor area in his cases was of the order of 3,500 r. Higher doses result in excessively severe skin reactions. Baclesse[1] feels that it requires a tumor dose of 5,000 r in order to obtain a clinical disappearance of the primary tumor in a significant proportion of the cases.

COMMENT

It would seem that in our series of 1,034 patients with carcinoma of the breast, there was no significant addition to five year survival when irradiation was combined with operation, or when irradiation alone was employed. The early cases were sudmitted to operation and the more advanced cases were given operation plus irradiation. In these more advanced cases there were 309

TABLE X

TUMOR DOSAGE IN PRIMARY IRRADIATION OF THE BREAST WITH CASES CLASSIFIED BY RICHARDS' STAGE OF DISEASE CLASSIFICATION; RESULTS INDICATED BY DISAPPEARANCE OF TUMOR AND BY 5 YEAR SURVIVAL (CARCINOMA OF BREAST)

Tumor Dose to Breast	Total No. of Cases	Stage I			Stage II			Stage III			Stage IV			Stage V			Result (Totals)	
		No.	D*	5*	No.	D	5	No.	D	5	No.	D	5	No.	D	5	D	5
50– 499 r	12	0	0	0	1	0	0	0	0	0	1	0	0	10	0	0	0	0
500–1,499 r	24	0	0	0	0	0	0	6	0	1	6	2	0	12	1	0	3	1
1,500–2,999 r	20	1	0	1	0	0	0	0	0	0	6	1	0	13	0	0	1	1
3,000–3,999 r	19	0	0	0	0	0	0	1	0	0	9	0	1	9	1	0	1	1
4,000–4,999 r	12	1	0	0	0	0	0	2	1	1	4	0	1	5	0	0	1	2
5,000 r and over	3	0	0	0	0	0	0	0	0	0	2	0	0	1	0	0	0	0
TOTAL	90†	2	0	1	1	0	0	9	1	2	28	3	2	50	2	0	6	5

* D—indicates disappearance of tumor; 5 indicates 5 year survival.
† Three additional cases not codable as to calculation of tumor dose.

TABLE XI

TUMOR DOSAGE IN PRIMARY IRRADATION OF THE BREAST WITH REFERENCE TO THE INFLUENCE OF TIME OF DELIVERY OF TUMOR DOSAGE ON DISAPPEARANCE OF TUMOR AND 5 YEAR SURVIVALS (CARCINOMA OF BREAST)

Tumor Dose to Breast	Total No. of Cases	1–10 days			10–30 days			1–3 mo.			3 mo.–1 yr.			1 yr. and over			Result (Totals)	
		No.	D*	5*	No.	D	5	No.	D	5	No.	D	5	No.	D	5	D	5
50– 499 r	12	8	0	0	0	0	0	2	0	0	2	0	0	0	0	0	0	0
500–1,499 r	24	6	1	0	7	0	0	4	0	1	4	1	0	3	1	0	3	1
1,500–2,999 r	20	1	0	0	7	1	0	7	0	1	4	0	0	1	0	0	1	1
3,000–3,999 r	19	1	0	0	5	0	0	7	1	1	5	0	0	1	0	0	1	1
4,000–4,999 r	12	0	0	0	2	0	0	3	0	0	3	0	0	4	1	2	1	2
5,000 r and over	3	0	0	0	0	0	0	0	0	0	2	0	0	1	0	0	0	0
TOTAL	90†	16	1	0	21	1	0	23	1	3	20	1	0	10	2	2	6	5

* D—indicates disappearance of tumor; 5 indicates 5 year survival
† Three additional cases not codable as to calculation of tumor dose.

local recurrences out of a total of 557 patients, or 55.4 per cent local recurrence. The patients who received primary irradiation to the breast, with few exceptions, did not receive as large a tumor dosage as the patients reported by Lenz, Richards and Baclesse.

SUMMARY

1. In a series of 1,034 patients with carcinoma of the breast, seen at the Hospital of the University of Pennsylvania between 1923 and 1943, 362 had operation alone, 557 had operation combined with irradiation, and 110 received irradiation only.

2. The cases were classified according to Portmann's four group or four stage clinical classification for primary cases of cancer of the breast and Richards' five stages of disease classification for mammary carcinoma.

3. In this series, the gross five year survival statistics show that of the 1,029 coded cases, there was a five year survival rate of 49.7 per cent with operation; 32.3 per cent with operation plus irradiation; and 5.4 per cent with irradiation alone. The over-all survival rate for the 1,029 of the 1,034 cases was 35.5 per cent.

4. Our results with irradiation alone to the breast do not compare favorably with more recent statistics from Lenz, Richards and Baclesse. Only 15 out of our 90 patients given primary irradiation to the breast received more than 4,000 tissue roentgens and the time of administration in most instances was over a long period. Lenz, Richards and Baclesse believe that the tissue dose should be 5,000 r delivered in a relatively short time.

Eugene P. Pendergrass, M.D.
3400 Spruce St.
Philadelphia 4, Pennsylvania

REFERENCES

1. BACLESSE, F. Roentgen therapy as sole method of treatment of cancer of breast. AM. J. ROENTGENOL. & RAD. THERAPY, 1949, *62*, 311–319.
2. LENZ, M. Tumor dosage and results in roentgen therapy of cancer of breast. AM. J. ROENTGENOL & RAD. THERAPY, 1946, *56*, 67–74.
3. PENDERGRASS, E. P., and HODES, P. J. Some observations on carcinoma of breast. AM. J. ROENTGENOL. & RAD. THERAPY, 1938, *39*, 397–406.
4. PENDERGRASS, E. P., and HODES, P. J. Further observations on carcinoma of breast. AM. J. ROENTGENOL. & RAD. THERAPY, 1939, *42*, 393–403.
5. PENDERGRASS, E. P., and KIRSH, D. Role of irradiation in management of carcinoma of breast. *Radiology*, 1948, *51*, 767–778.
6. PORTMANN, U. V. Clinical and pathologic criteria as basis for classifying cases of primary cancer of breast. *Cleveland Clin. Quart.*, 1943, *10*, 41–47.
7. RICHARDS, G. E. Mammary cancer; place of surgery and of radiotherapy in its management. *Brit. J. Radiol.*, 1948, *21*, 109–127; 249–258.

Vol. 72, No. 2

THE ROLE OF CORTISONE IN PREVENTING PULMONARY FIBROSIS FOLLOWING IRRADIATION

PRELIMINARY REPORT

By RICHARD M. FRIEDENBERG, A.B., M.D.,* *and* SIDNEY RUBENFELD, M.D., F.A.C.R.†
NEW YORK, NEW YORK

THIS investigation was undertaken to determine whether or not cortisone would inhibit the formation of pulmonary fibrosis in patients receiving radiation therapy to the thorax.

Permanent damage to the pulmonary parenchyma after irradiation has been described by numerous authors.[3,4,6,7,19] Although no threshold dose to pulmonary tissue which will result in fibrosis has been established, it is generally accepted that the greater the quantity of radiation and volume of tissue exposed, the greater chance of radiation fibrosis. Widmann,[21] in 1942, presented a series of cases receiving radiation therapy for breast carcinoma in which fibrosis developed two to eighteen months after therapy. He demonstrated that in addition to total dosage and volume of tissue irradiated, pathologic processes within the pulmonary parenchyma (such as metastatic tumor) greatly increased the probability of fibrosis. It has also been shown that treatment over the hilus causes a greater degree of fibrosis than treatment over the periphery of the lung. Shields Warren classified radiation effects on the respiratory system into three stages. The early reaction consists of congestion, edema, lymphectasis, slight inflammatory cell infiltration, and minimal changes in the tracheal epithelium. Moderate reactions consist of active degeneration or obvious injury to the epithelium with formation of a hyaline membrane. Late effects from heavier doses consist of thickening of the alveolar walls, patchy atelectasis, vascular changes and fibrosis, especially if intercurrent infection is present.

RATIONALE FOR THE USE OF CORTISONE

There have been numerous reports documenting the ability of cortisone or ACTH to inhibit the formation of fibrous tissue. Ragan *et al.*[12,13] demonstrated that rabbits receiving cortisone prior to the infliction of ear wounds showed (in contrast to the controls) a striking depression of new growth of all elements of connective tissue and decrease in the amount of granulation tissue. In the cortisone treated rabbits, new fibroblasts were rare, new blood vessels hardly seen and ground substance was decreased. With experimentally produced fractures of the femur, the fibroplasia, which would normally appear in four days and become marked by the eighth day, was very slight after eight days in cortisone treated animals. Spain *et al.*[18] and Shapiro *et al.*[16] independently studied the effect of cortisone in animals with experimentally produced turpentine abscesses, noting a definite interference with the formation of granulation tissue and the production of smaller, flatter, and less branched fibroblasts, but little evidence of any fibrolytic action of cortisone on already existing granulation tissue. Aterman[1] produced fibrosis of the liver in rats using carbon tetrachloride. In rats pre-tested with cortisone, the liver contained considerably less collagen and reticulin than in control animals. Scheinberg and Saltzstein[15] produced intra-abdominal adhesions in dogs by sprinkling talcum over the serosal surface of the small intestine. All control animals developed dense masses of adherent loops of intestine, while in cortisone treated animals there was a normal thin serosa.

* Formerly National Cancer Institute Fellow in Radiation Therapy at Bellevue Hospital; now Captain in the Army Medical Corps.
† Professor of Clinical Radiology at New York University College of Medicine; Director of Radiation Therapy, Bellevue Hospital, New York.

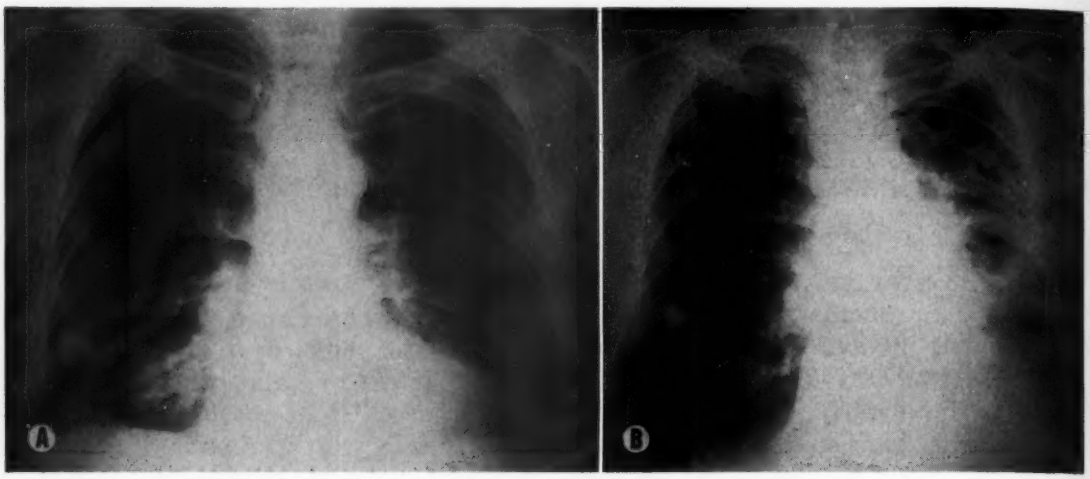


FIG. 1. (*A*) (*B*) Development of pulmonary fibrosis after radiation therapy to a carcinoma of the left main bronchus which received 6,200 r in six weeks.

Rosenberg and associates[14] were able to prevent lye strictures of the esophagus in rabbits by the use of cortisone. Numerous reports indicate that various chronic pulmonary diseases such as sarcoidosis, berylliosis, silicosis, and nonspecific pulmonary granulomatosis can be favorably influenced by the administration of cortisone.[9,10,17,20] Not only was there resolution of the pathologic process as visualized by the roentgen ray, but laboratory tests also revealed actual increases in the oxygen diffusing capac-

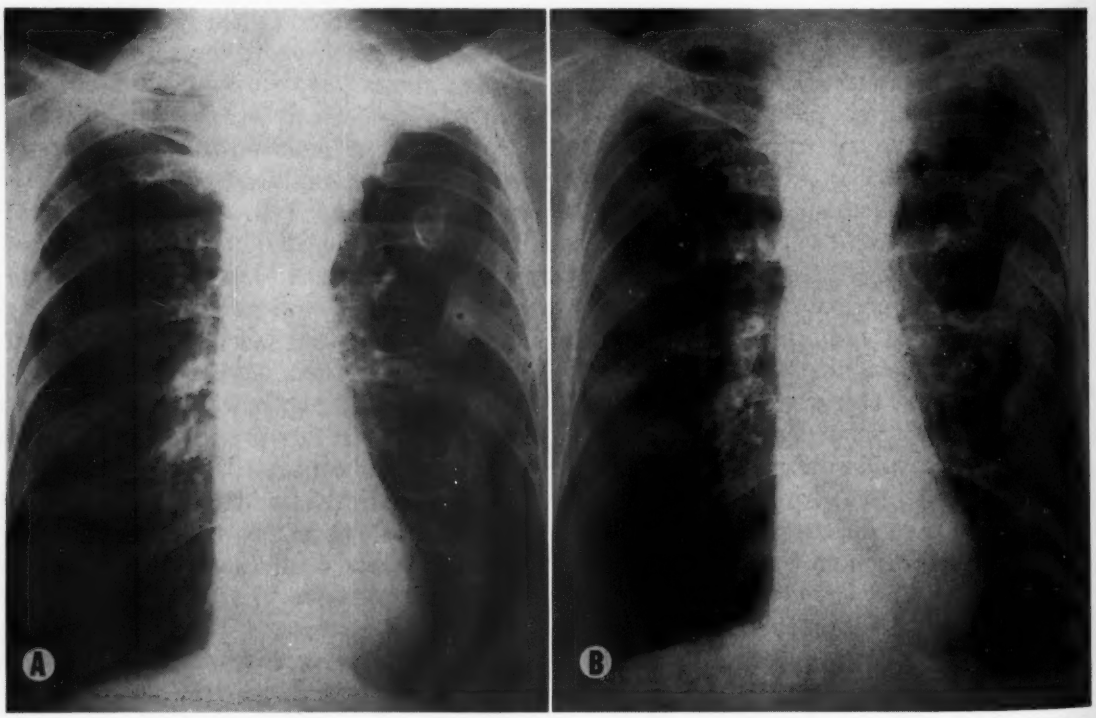


FIG. 2. Case 1. (*A*) shows a lesion in left upper lobe which received a calculated depth dose of 12,000 r in divided courses. (*B*) This roentgenogram, taken five months after commencing therapy and after 5,600 mg. of cortisone, shows no evidence of fibrosis.

ity of the lung.[5,11] Cosgriff and Kligerman[2] made the first clinical report of a favorable response from ACTH and cortisone in a patient who had developed an acute radiation reaction in the lung after a tissue dose of 4,500 roentgens. They noted both a marked symptomatic relief and objective improvement as visualized roentgenographically. Experimental evidence therefore seemed to indicate that cortisone and ACTH are able to inhibit fibroblastic proliferation which would normally occur following trauma to tissue.

As to the mechanism of action of cortisone in inhibiting connective tissue formation, Aterman believed that the amount of connective tissue present at any particular time is the result of an equilibrium between its deposition and removal. In progressing fibrosis, the equilibrium is disturbed by some injurious agent so that more is being formed than removed. Cortisone may act either as an inhibitor of cellular activity during the formation of fibrous tissue or may increase the rate of removal and re-establish the pre-existing equilibrium. Ragan and his associates believed it acted as the former, namely by inhibiting the formation of connective tissue.

METHODS AND MATERIALS

The cases selected were histopathologically proved carcinomas treated with intensive roentgen therapy. Cortisone was given orally in 100 mg. daily doses starting one week after the beginning of roentgen therapy and continuing one to two weeks after therapy was completed. The low dosage rate of cortisone was selected to avoid toxicity. All patients were weighed daily, questioned regarding cough, dyspnea, edema, appetite, and pain, and had chest roentgenograms taken semimonthly. The majority were markedly debilitated when first seen.

Roentgenographic evidence of pulmonary fibrosis after roentgen therapy is in the file of every radiologist. The case of one such patient is presented. The films show the development of pulmonary fibrosis over a six month period following roentgen therapy (6,200 r) to a carcinoma of the left main bronchus (Fig. 1*A* and *B*).

Table I

Patient	Diagnosis	Therapy Time/Dose	Cortisone Dosage on Basis of 100 mg. Daily	Fibrosis
J.L.‡	Cancer of lung (LUL)	7,900*/47 days 8,000 grid†/28 days	3,600 mg.	o
K.McG.	Cancer of lung	32,000 r grid†/51 days	2,800 mg.	o
B.N.	Reticulum cell sarcoma	3,000 r*/27 days	2,700 mg.	o
I.K.‡	Hypernephroma; metastasis to rib	6,424 r grid*/27 days	3,000 mg.	o
R.P.‡	Cancer of lung	32,400 r grid†/64 days	2,600 mg.	o
G.C.	Cancer of lung	13,800 r grid†§/32 days	2,100 mg.	o
J.V.	Cancer of esophagus	38,400 r grid†/65 days	3,800 mg.	o
R.T.	Cancer of lung	6,000 r*/70 days	2,300 mg.	o
J.T.	Cancer of esophagus	26,000 r grid†/63 days	2,700 mg.	o
E.E.‡	Cancer of lung	27,600 r grid†/62 days	2,000 mg.	

* Roentgen-ray doses are expressed as tissue dosages.
† Grid doses are total doses for single or opposing fields.
‡ This patient will be considered in detail below.
§ Treatment incomplete.
All patients were treated with roentgen rays of half-value layer 1 or 2 mm. Cu; target-skin distance 50 cm., 200 kv., and 20 ma.

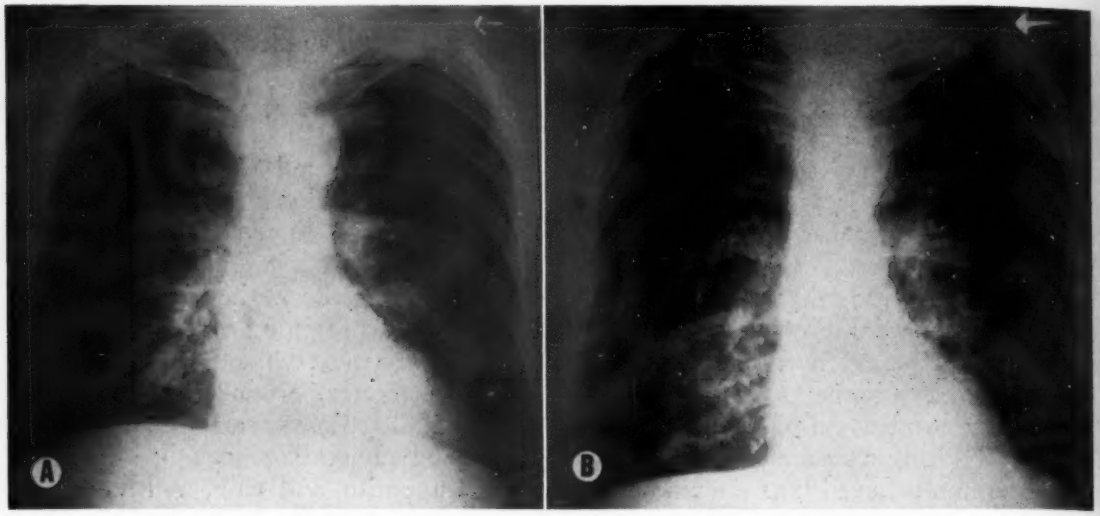


FIG. 3. Case II. (*A*) shows the lung parenchyma prior to roentgen therapy to a metastatic lesion in the left second rib from a hypernephroma. (*B*) This roentgenogram, taken three months after completion of a tissue dose of 6,400 r and 3,000 mg. of cortisone shows a normal appearing lung.

RESULTS

Table I itemizes the time-dose relationship, the total dose of cortisone and the result for each of the ten patients treated.

Table II presents the observation period on these patients from the completion of therapy to the present or to the time of death.

No roentgen fibrosis was seen in any of these patients.

TABLE II

Months of observation	1	3	4	5	6	13
Number of patients	3	2	1	1	2	1*

* R.P., treated with cortisone nine months after fibrosis occurred following therapy; considered in detail in case reports.

Associated symptoms, although of secondary interest in this study, frequently showed dramatic improvement during cortisone administration. These changes are tabulated in Table III.

TABLE III

	Increase	Decrease	Unchanged
Pain	0	3	4
Dyspnea		3	2
Weight	1	2	3
Cough		3	4
Appetite	4	3	3

CASE REPORTS

CASE I. J.L. This patient had two courses of intensive therapy with a depth dose of 12,000 r to the left upper lobe. Figure 2*A* shows the lesion in the left upper lobe before treatment. Figure 2*B* is a film five months after commencing therapy. No evidence of pulmonary fibrosis is seen. This patient after receiving such an intensive tissue dose should have shown fibrosis. He was doing well clinically when he committed suicide. Autopsy disclosed no tumor in the treated zone, but a large mass in the untreated mediastinum. Fibrosis was conspicuously absent.

CASE II. I.K. This patient was treated for metastasis to the second rib from a hypernephroma. Figure 3*A* shows the lung parenchyma prior to therapy. A roentgenogram (Fig. 3*B*) taken three months after a tumor dose of 6,400 r reveals no objective evidence of fibrosis.

CASE III. E.E. This patient was treated for bronchogenic carcinoma of the right lower lobe. Figure 4*A* shows the chest at the time radiation therapy through a grid was started. A roentgenogram (Fig. 4*B*) taken three months after administration of 27,000 r (air) and after 2,000 mg. of cortisone shows no evidence of recent fibrosis.

CASE IV. R.P. This patient was treated with grid therapy in July, 1951, over opposing anterior and posterior fields, with a total dose

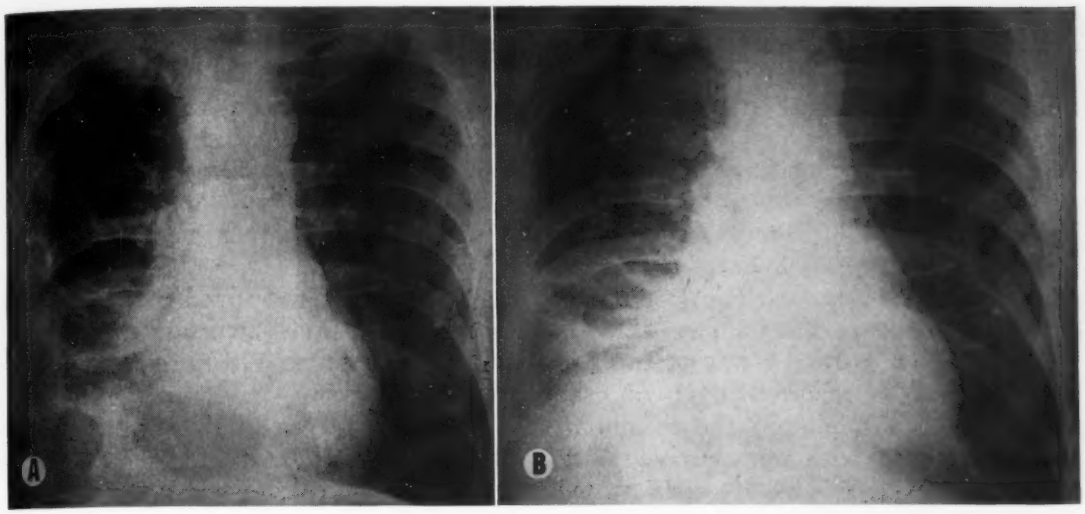


Fig. 4. Case III. (*A*) and (*B*) show no advance in fibrosis after a dose of 27,000 r (air grid) and 2,000 mg. of cortisone. During this three month interval, the patient experienced marked symptomatic improvement.

of 32,400 r (in air) and a calculated average depth dose of 6,300 r. Four months after completion of therapy, the patient developed massive fibro-atelectasis of his entire right lung, with progressively increasing dyspnea, cough, and chest pain (Fig. 5*A*). Following 3,600 mg. of cortisone, the dyspnea and cough completely disappeared, the chest pain became mild, his appetite improved, and he gained 8 pounds in weight, although no objective improvement was noted in the roentgenogram (Fig. 5*B*). The cortisone was stopped four months ago but his improvement has remained constant to the present time.

DISCUSSION

Precise evaluation of a study of this nature is impossible until the following

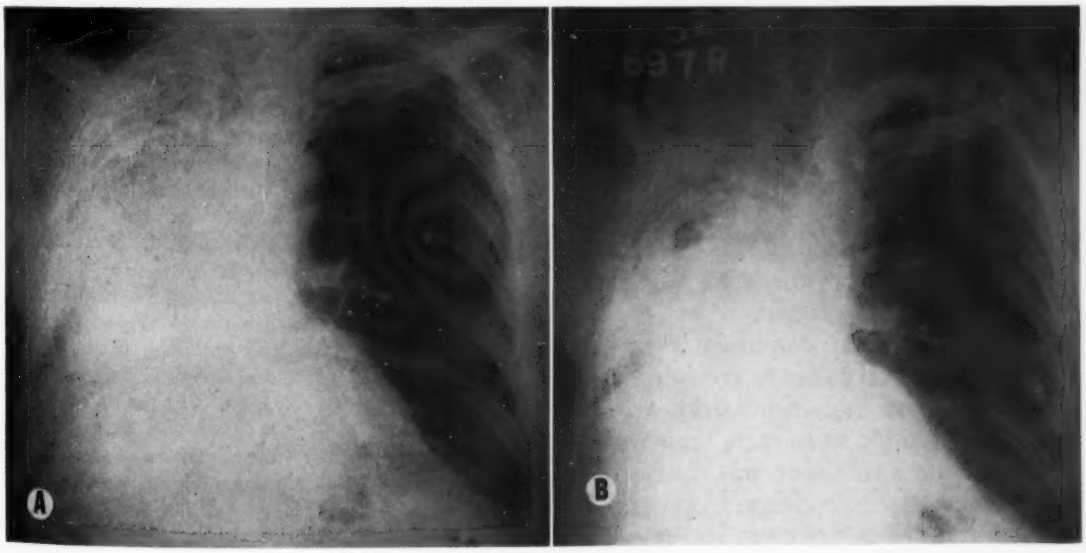


Fig. 5. Case IV. (*A*) shows extensive fibrosis and atelectasis of the entire right lung four months after administration of a dose of 32,400 r (air grid). Dyspnea, cough and pain were severe. (*B*) This roentgenogram, taken following 3,600 mg. of cortisone, reveals no significant changes. The symptoms, however, were markedly improved. This patient has been followed for thirteen months.

questions can be answered: (1) What percentage of individuals receiving deep roentgen therapy will develop fibrosis? (2) What time interval is necessary for its development? The answers are obviously not available. Patients receiving large tissue doses over large areas were chosen because of a higher probability of fibrotic reaction. Six patients who have been followed over three months have not shown clinical or roentgenological evidence of pulmonary fibrosis.

The dosage of cortisone was determined from previously reported data on the amount needed to obtain the maximum therapeutic effect with comparative safety from serious side effects. Kendall[8] stated that most individuals can tolerate 100 mg. of cortisone for a month or more without showing undesirable effects or significant changes in the acid-base balance. With 200 mg. daily, some patients will exhibit changes in ten to fourteen days. Kendall also believed that when treatment is extended, large daily doses are not necessary. Ragan and associates,[13] however, working with rabbits, found that doses equivalent to 500 mg. in a 50 kilogram man completely inhibited the formation of all elements of connective tissue. At lower dosage levels, equivalent to 100 mg. in a 50 kg. man, there was a delay in the formation of granulation tissue rather than its complete suppression. With 100 mg. per day it was felt that we were using the maximum dosage compatible with relative freedom from complications. No toxicity to cortisone was exhibited. One patient (R.T.) developed a lung abscess in which cortisone might have been a contributing factor.

Deserving special emphasis is the fact that none of the patients receiving cortisone developed radiation sickness. Two patients were able to tolerate their residual pain even after cortisone was discontinued without recourse to codeine. In general, appetite improved, weight was increased, and cough decreased.

SUMMARY

(1) Nine patients were given cortisone while receiving roentgen therapy to the thorax.

(2) In no instance has pulmonary fibrosis appeared in the zone of irradiation despite the intensive doses given. Six patients have been followed over three months.

(3) Subjective improvement was observed.

(4) One patient received cortisone for a severe reaction following roentgen therapy with marked symptomatic improvement.

(5) This report suggests that cortisone may be of value in inhibiting pulmonary fibrosis following irradiation.

Sidney Rubenfeld, M.D.
Radiation Therapy Dept.
Bellevue Hospital
New York 16, New York

REFERENCES

1. Aterman, K. Effect of cortisone on early fibrosis of liver in rats. *Lancet*, 1950, *2*, 517–519.
2. Cosgriff, S. W., and Kligerman, M. M. Use of ACTH and cortisone in treatment of post-irradiation pulmonary reaction. *Radiology*, 1951, *57*, 536–540.
3. Desjardins, A. U. Reaction of pleura and lungs to roentgen rays. Am. J. Roentgenol. & Rad. Therapy, 1926, *16*, 444–448.
4. Evans, W. A., and Leucutia, T. Intrathoracic ranges induced by heavy irradiation. Am. J. Roentgenol. & Rad. Therapy, 1925, *13*, 203–220.
5. Ferris, B. G., Affeldt, J. E., Kriete, H. A., and Whittenberger, J. L. Symposium on treatment of chronic beryllium poisoning with ACTH and cortisone; pulmonary function in patients with pulmonary disease treated with ACTH. *A.M.A. Arch. Indust. Hyg.*, 1951, *3*, 603–616.
6. Freid, J. R., and Goldberg, H. Post-irradiation changes in lungs and thorax; clinical, roentgenological and pathological study with emphasis on late and terminal stages. Am. J. Roentgenol. & Rad. Therapy, 1940, *43*, 877–895.
7. Jacobsen, V. C. Complications of deep x-ray therapy of carcinoma of lung. *Am. J. Med.* 1948, *5*, 148–156.
8. Kendall, E. C. Cortisone. *Ann. Int. Med.*, 1950, *33*, 787–796.
9. Kennedy, B. J., and others. Effect of adrenocorticotropic hormone ACTH on beryllium granulomatosis and silicosis. *Am. J. Med.*, 1951, *10*, 134–155.

10. Lovelock, F. J., and Stone, D. J. Cortisone therapy of Boeck's sarcoid. *J.A.M.A.*, 1951, *147*, 930–932.
11. McClement, J. Symposium on treatment of chronic beryllium poisoning with ACTH and cortisone; information gained in pretherapy and post-therapy pulmonary function studies. *A.M.A. Arch. Indust. Hyg.*, 1951, *3*, 599–602.
12. Ragan, C., and others. Effects of cortisone on production of granulation tissue in rabbit. *Proc. Soc. Exper. Biol. & Med.*, 1949, *72*, 718–721.
13. Ragan, C., Howes, E. L., Plotz, C. M., Meyer, K., Blunt, J. W., and Lattes, R. Effect of ACTH and cortisone on connective tissue. *Bull. New York Acad. Med.*, 1950, *26*, 251–254.
14. Rosenberg, N., Kunderman, P. J., Vroman, L., and Moolten, S. E. Prevention of experimental lye strictures of esophagus by cortisone. *A.M.A. Arch. Surg.*, 1951, *63*, 147–151.
15. Scheinberg, S. R., and Saltzstein, H. C. Effect of cortisone and corticotrophin (ACTH) on intra-abdominal adhesions. *A.M.A. Arch. Surg.*, 1951, *63*, 413–420.
16. Shapiro, R., Taylor, B., and Taubenhaus, M. Local effects of cortisone on granulation tissue and role of denervation and ischemia. *Proc. Soc. Exper. Biol. & Med.*, 1951, *76*, 854–857.
17. Small, M. J. Favorable response of sarcoidosis to cortisone treatment. *J.A.M.A.*, 1951, *147*, 932–937.
18. Spain, D. M., Molomut, N., and Haber, A. Biological studies on cortisone in mice. *Science*, 1950, *112*, 335–337.
19. Warren, S., and Spencer, J. Radiation reaction in lung. Am. J. Roentgenol. & Rad. Therapy, 1940, *43*, 682–701.
20. West, J. R., and others. Effects of cortisone and ACTH in cases of chronic pulmonary disease with impairment of alveolar-capillary diffusion. *Am. J. Med.*, 1951, *10*, 156–165.
21. Widmann, B. P. Irradiation pulmonary fibrosis. Am. J. Roentgenol. & Rad. Therapy, 1942, *47*, 24–38.

INTERSTITIAL RADIUM TREATMENT OF CANCER OF THE CERVIX UTERI*

CLINICAL APPRAISAL

By JAMES A. CORSCADEN, M.D., S. B. GUSBERG, M.D., *and* WALTER KOSAR, M.D.
NEW YORK, NEW YORK

THIS is a report of a trial of the interstitial technique of radium therapy in the treatment of 108 cases of cancer of the cervix uteri. First, we wished to learn whether injuries, so often spoken of as inevitable with this method, were important; second, to compare the clinical results with those obtained by us following use of the intracavitary technique; and third, to see if the technique could be improved in such a way as to raise the number of clinical cures and lower the number of injuries.

Stimulated by the work of Waterman and his coworkers,[5] by the need of improvement in results following the treatment of extensive cervical cancer by the intracavitary method, and by the reasonableness of a technique which could deliver heavy doses of radiation from sources placed within the cancer, we, in 1944, began to use this method.[1] In principle, the inability of the intracavitary technique to deliver adequate doses to the lateral pelvis would be overcome and the injurious effects of external irradiation to superficial structures would be obviated. Concentration of energy from the sources placed within the cancer would be maximum at that point, whereas rays from external sources would deliver a maximum dose to the skin and a minimum dose to the center of the tumor.

METHOD

We soon saw that the whole accessible space in which cancer spread should be irradiated in addition to that in which the tumor was clinically apparent. A pattern was worked out by which 20 to 30 milligrams in a tandem were inserted into the uterus. A stockade of needles was inserted into the cervix. The radius of the circle was 1.5 cm.; the needles 1 cm. apart, eight in number, 3.2 cm. long, active length 2 cm., containing 1.98 mg. of radium. In the paracervical region on each side 3 cm. from the midline in a sagittal plane, two 3.2 needles, 1 cm. apart, were inserted. Along the pelvic wall, 4.5 cm. from midline in another sagittal plane were inserted 5 needles 6 cm. long, 5 cm. active length, containing 5 mg. of radium. The filter of the tubes was 1 mm. Pt, that of the needles 0.5 mm. Pt. The application lasted 120 hours.

The general thought underlying this distribution was that cancer of the cervix spreads by extension rather than by metastasis and that therefore radiation must be delivered to all of the channels through which the cancer might spread. This means that we not only have to irradiate the cervix, points A, B, and the lymph nodes, but all the space between the cervix and pelvic wall, between the peritoneum above and posteriorly and bladder anteriorly, and that space which lies lateral to the vagina as well as the cervix. The "parametrium" becomes a definite space with definite boundaries instead of a vague region.

The importance of this regional approach has been recently demonstrated by Gusberg and Fish[3] in a study of 100 specimens of cancer of the cervix removed by radical hysterectomy. From this study it is apparent that every cubic centimeter of the region described is potentially cancerous.

The actual pattern used was "ideal" in only 3 of the cases in this series. Because of the narrowness of the vagina in many cases and caution on the part of the operator, the extent of the installation was restricted. Only three needles were introduced into each lateral pelvis in 83 cases. In 36 of these

* From the Department of Obstetrics and Gynecology, Columbia University, New York, New York. Presented at the Thirty-fifth Annual Meeting, American Radium Society, St. Louis, Mo., April 20–22, 1953.

the paracervical needles were lacking. In 7 the tandem was lacking and in 1 a narrow conical vagina permitted the introduction of only five small needles.

In 19 cases the pattern was "irregular." In 7 cases a few scattered needles were added to an intracavitary application. In 3 stump cases the needles were irregularly and scantily placed. In 6 cases needles were placed in vaginal or parametrial recurrences following failure of intracavitary radium or hysterectomy. In 1 case a vaginal bomb was introduced, together with a few parametrial needles. In 2 cases a few needles were placed in an advanced case to control bleeding. In the first 3 cases treated the needles were inserted without any clear cut pattern.

INJURIES

Almost the first point raised, whenever interstitial radium technique is discussed, is that because of the "blind" nature of this procedure, there will be frequent mechanical injury to intestine, bladder or ureter; second, that because of inaccuracies in the direction of the needles, there will be "hot" and "cold" spots with necrosis about the former and inadequate radiation about the latter.

Surgical Injuries. In the 108 cases here reported there was no evidence that a needle had punctured bladder, ureter or intestine. There was 1 case of extrapelvic infection and 4 cases in which a vein had evidently been punctured.

The infected case was treated in the early days when an attempt was made to fan the needles out laterally from the region of the cervix. While the pelvis remained completely clear, an abscess developed about the upper end of the femur causing gross destruction of bone. We assumed that the point of the needle had punctured the pelvic fascia and that the tissues underlying the fascia were susceptible to infection which travelled out through the sacrosciatic notch. The patient recovered and is cancer free eight years after treatment.

In 4 cases brisk bleeding followed the withdrawal of the needles. This was controlled in all cases by vaginal packing. No pelvic hematomas were palpable. It is assumed that a needle punctured a vein.

A needle was lost in 3 cases and recovered without incident after roentgen localization of the foreign body.

We conclude, therefore, that surgical injury to hollow viscera has not been an important complication. In less than half of the cases have the needles been inserted by the two surgeons most interested (J.A.C. and S.B.G.). In the remainder of the cases the needles have been introduced by other members of the attending staff or by various members of the house staff. It would appear that only average surgical skill is needed. This must be kept in mind when comparing injuries by this technique with those caused by operations performed by exceptionally gifted surgeons. However, great care must be taken to visualize the normal anatomy. There is no excuse for pushing a needle through the posterior wall of the uterus into the peritoneal cavity. The proper direction of the needle is readily established by a sound in the uterine canal.

The needles in the paracervical region must be short and inserted in the axis of the uterus. There is about 3 cm. of tissue between the vault of the vagina and the peritoneum at a point 3 cm. lateral to the internal os. The needles in the parametria 5 cm. from the midline are safe if they parallel the axis of the pelvis.

Radiation Injuries. Of the injuries caused by radiation 2 were important (Table 1). One was a rectovaginal fistula which occurred following treatment of an extensive Stage II cancer complicated by a lymphogranulomatous stricture of the rectum and syphilis. A colostomy was performed. The patient is well eight years after irradiation.

The other was of a woman with a Stage III carcinoma. The vaginal vault was contracted. The uterine canal was not established. One 10 milligram tube of radium was inserted in the crater of the cancer, five 2 mg. needles were inserted into the cervix, then in each side two 2 mg. needles lateral

TABLE I

CANCER OF THE CERVIX UTERI. INJURIES IN PATIENTS TREATED BY INTERSTITIAL RADIUM

	Irradiation	Cancer	Doubt	Post-hysterectomy
Cystitis	2	—	—	—
Hemorrhagic cystitis	5	—	—	—
Bladder ulcer	3	2	—	—
Telangiectasis	1	—	—	—
Vesicovaginal fistula	—	1	1	—
Ureteral obstruction	1	7	1	—
Ureterovaginal fistula	—	—	—	1*
Proctitis	4	—	—	—
Hemorrhagic proctitis	3	—	—	—
Ulcer	1	—	—	—
Rectovaginal fistula	1*	—	—	—
Partial obstruction	1	—	—	—
Complete obstruction	—	2	—	—
Vaginal ulcer	3	—	—	—

* See text.

to this, and three 5 mg. needles lateral to these. The lateral distances were shortened. The 58 mg. was left in place for 158 hours. An ulcer of the vaginal vault bled profusely five months later. Thirty milligrams of radium in a pack were placed in the ulcer for seventy hours to stop the bleeding. The patient became uremic and died. Autopsy showed intense edema obstructing the ureter. No cancer was found. The excessive irradiation in this case is apparent.

The other injuries to the bladder were simple cystitis (2 cases), hemorrhagic cystitis in which there were bleeding points in the inflamed area without visible necrosis (5 cases), typical radiation ulcer (3 cases) and 1 case in which the bladder wall atrophied. In this pale mucous membrane numerous telangiectatic veins could be seen.

These cases were troublesome but not serious except in 2 cases which were badly managed. In 1 case with hemorrhagic cystitis, the urologist catheterized the ureters. The right kidney became infected and had to be removed. In another similar case one year after treatment of a Stage III cancer, hematuria occurred. A surgeon performed a suprapubic cystotomy. The patient died on the tenth day after operation from a pulmonary embolus. A complete autopsy revealed no residual cancer. These cases should have been treated conservatively. If caused by radium they heal rather quickly. Ulcers may become encrusted with urinary salts and require more active treatment. None of the ulcers here described were involved in this way.

The other important complications in the urinary and intestinal tract were caused by progressing cancer.

There were 2 such cases in which the radiation may have contributed but did not play a major role. One was a vesicovaginal fistula which followed simple complete hysterectomy for an extensive Stage II cancer, recurrence and the application of radium to the vault and left parametrium. There was cancer in the fistulous tract.

In another woman, following treatment there was a right hydronephrosis which preceded a massive recurrence in the pelvis.

In another interesting case, a Stage III cancer was treated by the interstitial method. All induration disappeared but there remained definite cancer on the cervix. A radical Wertheim hysterectomy was performed. There followed a right ureterovaginal fistula and cicatricial stenosis of the left ureter. Ureteroneocystostomy was carried out. The patient is well four years after operation.

This experience supports the validity of the suggestion by Kligerman and Richmond[4] that the strength of the radium in the uterus should be lowered and the duration of the application lengthened to 144 hours.

By cutting in half the radium in the tandem to 15 mg. and that in the needles in the stockade to 1 mg. in an active length of 2 cm., the dose delivered to the cervix would

TABLE II

CANCER OF THE CERVIX UTERI. CLINICAL RESULTS FOLLOWING INTERSTITIAL RADIUM

	5 yr.+		4 yr.		3 yr.		2 yr.		1 yr.	
	No.	Well	No.	Well	No.	Well	No.	Well	No.	Well
Stage I	1	1	—	—	—	—	—	—	—	—
Stage II										
Limited	9	4 (3)	2	2	3	2	1	1	2	2
Extensive	13	7 (2)	2	0	1	1	1	1	5	2
Stage III										
Primary	24	3 (1)	10	2	7	0 (2)	5	1	7	6
Secondary	4	0	3	0	—	—	2	0	—	—
Stage IV	3	0	—	—	2	1	1	0	—	—

Numbers in parenthesis indicate the number of cases not followed.

be lowered from 26,000 r gamma to 18,000 r gamma while the dose to a point 3 cm. lateral from the internal os and that to a point on the lateral pelvic wall would be maintained at 12,000 r gamma.

In some of these cases of proctitis the area affected was very wide, suggesting that external roentgen irradiation may have been the major factor, but a clear distinction between these lesions and those which were sharply localized, and therefore probably due to radium, could not be made. While the dose delivered to the tumor by the combined method must be kept high, it should be controlled by more accurate techniques for dosage calculation.

The principal cause of error from the standpoint of radiation technique has been inattention to the spacing of the needles. Doses delivered by this technique have been calculated on the basis of a 1 cm. distance between needles. In a conical vagina with a small surface of cervix exposed, there is a tendency to crowd the needles together in order to keep the number of milligrams inserted up to a preconceived number. Whether using one unit of radium or many needles, one must ever keep in mind the law of inverse squares.

CLINICAL RESULTS

The patients selected for treatment in this study have had, with one exception, cancers which had extended beyond the uterus.

Stage II was divided into two groups: those in which the extension was still limited and those in which the disease had spread close to the pelvic wall but had not invaded it. We did not feel justified in changing the technique previously used in the Stage I cases since the results were satisfactory (76 per cent in all Stage I cases; 79 per cent, if cases not followed are disregarded).

The five year results in the 54 cases treated more than five years ago are not startling but if they represent rates to be expected in larger numbers, they are significantly superior to those achieved by us following the intracavitary technique.[2] In the Stage II cases, including the limited and extensive cases together, there was a survival of 11 of 22 cases (50 per cent) and 11 of 18 cases (61 per cent) if the cases not followed are discarded.

In Stage III the results seem poor (3 of 24 cases, 12.5 per cent) but are three times as good as those which we had achieved with the intracavitary method.

Of course, these numbers are too small to have any statistical significance. Compared with the results obtained by others they are not high. The question of selection and definition naturally arises. We believe that our cases are not staged downward because, according to our interpretation, 34 per cent of all cases of cervical cancer admitted to Sloane Hospital have been classified as Stage I.

The cases treated from one to four years ago (Table II) show that the greatest mortality occurs during the first two years.

More striking than those numbers is the rapidity with which the bulky cancerous masses disappear. This, from the standpoint of palliation, is very important. The length of life in the fatal cases is not prolonged many months, but during that time the patients are free of a foul ulcerating mass in the vagina.

CONCLUSIONS

Interstitial radium in the treatment of cancer of the cervix uteri is safe. In this series of 108 cases only two serious radiation injuries have occurred.

Surgical injuries have been limited to one surgical infection and four cases in which a vein was punctured.

There is no evidence that a needle had punctured bladder, rectum or ureter.

The technique demands ordinary surgical skill but a precise knowledge of the anatomy of the pelvis, and an understanding of the principles of radiation therapy.

The clinical results following this method are superior to those obtained by the intracavitary technique, in our experience, in Stages II and III.

Efforts should continue to improve the distribution of the radium sources and in the devising of techniques to place the sources in the desired positions.

James A. Corscaden, M.D.
180 Fort Washington Ave.
New York 32, New York

REFERENCES

1. CORSCADEN, J. A., GUSBERG, S. B., and DONLAN, CHARLOTTE P. Precision dosage in interstitial irradiation of cancer of cervix uteri. AM. J. ROENTGENOL. & RAD. THERAPY, 1948, *60*, 522–534.
2. CORSCADEN, J. A. Treatment of early carcinoma of cervix uteri. *Am. J. Obst. & Gynec.*, 1950, *59*, 272–284.
3. GUSBERG, S. B., FISH, S. A., and WANG, Y. Y. Growth pattern of cervical cancer. *Obst. & Gynec.*, New York, Dec., 1953, *2*, 557–561.
4. KLIGERMAN, M. M., and RICHMOND, JEANNE D. Volume dosage distribution in female pelvis in radium therapy. AM. J. ROENTGENOL., RAD. THERAPY & NUCLEAR MED., 1953, *70*, 750–758.
5. WATERMAN, G. W., DILEONE, R., and TRACY, E Use of long interstitial radium needles in treatment of cancer of cervix. AM. J. ROENTGENOL. & RAD. THERAPY, 1947, *57*, 671–678.

DISCUSSION

DR. ALLAN BARNES, Columbus, Ohio. Dr. Corscaden has given us a very valuable first report on the results he has obtained. It seems to me that there is not a great deal that can be added to the report as he has presented it, and the principal thing a discusser might do under the circumstances is to outline a correlative experience in this particular pattern.

In 1948 we first started using Dr. Corscaden's pattern, and—as I am afraid was inevitable—immediately started making some modifications. However, curious as it my seem, these modifications were surprisingly minor to the extent that they might have influenced the pattern and the distribution of the irradiation.

The first of the modifications was the introduction of the plastic template to fit into the vagina. This I will not particularly defend. I know there are persons here who can do free-hand implants that are far better than are mine when guided by the templates. Let me simply say that I have been aided immeasurably by the use of these plates, which were turned out for the individual patients, with the holes drilled in them to guide the needles to their proper places.

The second of the modifications is an extremely interesting one, in that it did the very thing that Dr. Corscaden has concluded should be done. We abandoned the central tandem and replaced it with a plastic guide that would hold this in the cervical canal. Around this guide we placed the row of paracervical needles, then the intermediate paracervical needles, and finally the needles running almost parallel to the pelvic wall.

The next modification was to increase the needles until we got up to a range of 36 needles per implant. As you can see from this roentgenogram, the distribution of radioactive sources is perfectly symmetrical, and the "peppering" he describes is almost literally carried out. It looks as if many fine sources are thrown with incredible symmetry and smoothness across the distribution of the neoplasm.

The technique is not old enough to give us five year figures. We measured the even distri-

bution of this type of applicator in the group of patients with whom we followed Dr. Corscaden's pattern fairly consistently, then the group of patients in whom we didn't behave so wisely, and our increasing of the number of needles tended to raise the central dose.

We do have four year figures that can be prepared, but they mean nothing because the groups are too small.

In the League of Nations Stage IV, 6 patients in a group, none are living at four years.

In the League of Nations Stage III, 13 patients in the group, 15 per cent are living at the present time.

These two groups represent predominantly the groups in which we increased our central dosage, and in which we got the principal part of the bowel morbidity that has already been reported by Dr. Morton and Dr. Hendricks.

However, in the League of Nations Stage II, we had 18 patients during that year; 61 per cent are now living, so that we did well to equal Dr. Corscaden's 50 per cent at five years.

In the League of Nations Stage I, 11 patients, 10 of them are now living, or 91 per cent, and we bid well to equal or have a moderately respectable five year survival rate in Stage I.

When our central dosage was not too high, and when we took advantage of both our sources and our technique to give an even blanket of irradiation across the pelvis, we obtained our best results.

I do think that the pattern Dr. Corscaden has described, the contribution he has made, is an exceedingly valuable one, and the modification that he proposes at the present time is well worth heeding, because by reducing the central dosage and by eliminating the central tandem, he does achieve the even blanket, and a distribution that is anatomically proper.

TREATMENT OF TUMORS OF THE PELVIC CAVITY WITH SUPERVOLTAGE RADIATION*

By J. G. TRUMP, Sc.D., R. C. GRANKE, B.S., K. A. WRIGHT, B.A., B.S., *and* W. W. EVANS, M.S.

Massachusetts Institute of Technology

CAMBRIDGE, MASSACHUSETTS

and

HUGH F. HARE, M.D.,[1] EARL E. EWERT, M.D.,[2] *and* WILLIAM L. CONLON, M.D.[3]

The Lahey Clinic

BOSTON, MASSACHUSETTS

ROENTGEN therapy of tumors of the pelvic cavity, such as cancer of the uterine cervix and urinary bladder has long been among the more difficult problems both clinically and technically. Although Stage I tumors of the cervix have been relatively well controlled by interstitial and intracavitary radium, it is only in recent years that the greater penetration afforded by supervoltages has permitted the delivery of adequate doses in the more advanced stages of malignant pelvic disease. Thus, Richards,[4] of Toronto, showed 74 per cent five year symptom-free survival for Stage I cancer of the cervix treated by radium and roentgen radiation, but the survival figures rapidly fall to 50.5 per cent for patients with Stage II cancer, 26.8 per cent for Stage III and 4.9 per cent for Stage IV, with only 10 per cent of all patients falling in the Stage I category. Cancer of the bladder represents an even more difficult situation, especially in the deep infiltrating type. When the deep muscular and perivesical tissues are involved, approximately 3 per cent of the patients survive five years. If, however, there is only superficial infiltration, 74 per cent survive five years without recurrence[3] after surgical treatment.

A correct evaluation of the extent of the disease is essential to its successful treatment by radiation. In cancer of the cervix the possibility of early spread along the broad ligaments to the parametrial lymph nodes, to the iliac lymph nodes, and to other regions along the wall of the pelvic cavity is now generally recognized. When adequate gamma radiation has been delivered by radium to the evident disease in Stage I cancer of the cervix, the occasional failures must be ascribed to subclinical extension toward these more distant lymph nodes. Study of the progress of this disease has indicated that the greatest prospect for control would be obtained by delivering an adequate dose throughout the true pelvis. In the 2 mev. roentgen therapy program of the Massachusetts Institute of Technology and the Lahey Clinic, an effort is made to include the primary lesion, the surrounding lymphatics, and the tissue extending laterally within the confines of the true pelvis and as high as the promontory of the sacrum. This region is best approached rotationally since it is desired to irradiate a volume of a generally spherical shape centered in the pelvic cavity. The patient is therefore treated in the standing position and is turned about a vertical axis while exposed to a horizontal roentgen-ray beam of essentially circular shape. Special adjustments may be made to diminish the dose sustained posteriorly in order to protect the rectum.

Similarly, in the treatment of infiltrating cancer of the bladder, a spheroidal region containing all of the bladder and some of

* Presented at the Fifty-third Annual Meeting, American Roentgen Ray Society, Houston, Texas, Sept. 23–26, 1952.

[1] Department of Radiology.

[2] Department of Urology.

[3] Fellow in Radiology.

the surrounding lymphatic system is given a high and essentially uniform dose by rotational methods. The bladder field is similar although occasionally smaller than that used in the treatment of cancer of the cervix, and the vertical axis of rotation is moved slightly anterior to the position for cervix treatments.

An effort is made in both cervix and bladder cases to minimize the dose sustained by the small intestine by placing the patient in the Trendelenburg position prior to irradiation and binding the abdominal region with a 6 inch Ace bandage. This displaces the small intestine upward and at least partially out of the irradiated field. The lateral aspects of approaching the pelvic region, even though these necessitate the irradiation of the femoral neck, are routinely used and evidence is cited that the doses sustained by these weight-bearing bones are probably tolerable with supervoltage radiation even when high tumor doses are delivered.

In the following paragraphs are summarized the pelvic dose distributions which result from these irradiation techniques, the adjustments which were made to meet the improving clinical understanding of the rotational treatment with supervoltage radiation of tumors of the cervix and bladder, as well as the clinical impressions that have been gained thus far.

ROTATIONAL TECHNIQUE

Figure 1 shows the arrangement used in the rotational treatment of patients with pelvic disease, using 2 mev. constant potential radiation. The roentgen-ray source is a compressed gas insulated Van de Graaff accelerator contained in a steel tank about 3 feet in diameter by 6 feet in over-all length. The roentgen-ray beam is defined by a variety of adjustable lead and steel diaphragms and apertures so that any rectangular and circular as well as many complex shaped fields can be readily obtained. The "target to axis of rotation distance" (TAD) is 125 cm. The radiation proceeds from a spot about 3 mm. in diameter,

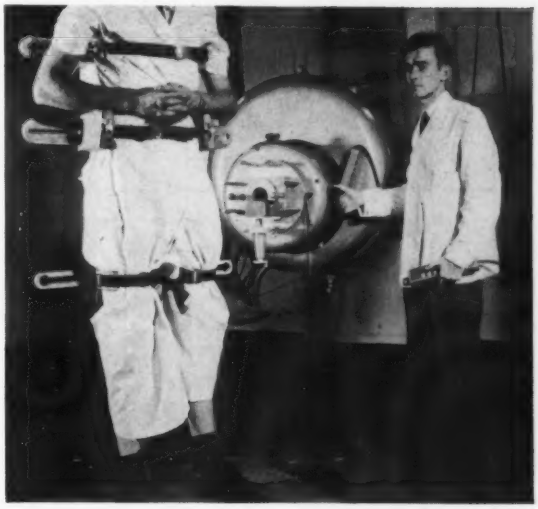


FIG. 1. Arrangement for treating pelvic disease rotationally with 2 mev. constant potential roentgen rays.

which represents the area of impact of the high energy electrons upon the water-cooled gold target. Further careful measurements of the ionization distribution in depth by a 10 by 10 cm. roentgen-ray beam produced at 2.0 mev. constant potential have given slightly higher values than those which we have previously reported, and these new depth dose data are therefore included in Figure 2.

Although any method of securing a relative movement of patient and roentgen-ray beam would be suitable, we have found it most convenient to maintain the roentgen-ray beam stationary during treatment and to rotate the patient upon a special table adequately provided for the patients firm support. The method of properly including the region to be treated has been described in our previous paper.[6] It includes the lining up of the patient in the anteroposterior and in the lateral position, making use of the two mutually perpendicular traverses on the table. In this setting-up procedure we are assisted by the visible light beam, which is coincident in position with the roentgen ray beam, and by the easy adjustability of the beam in height, angle and shape. The orientation of the table and roentgen-ray beam is such that the vertical central plane

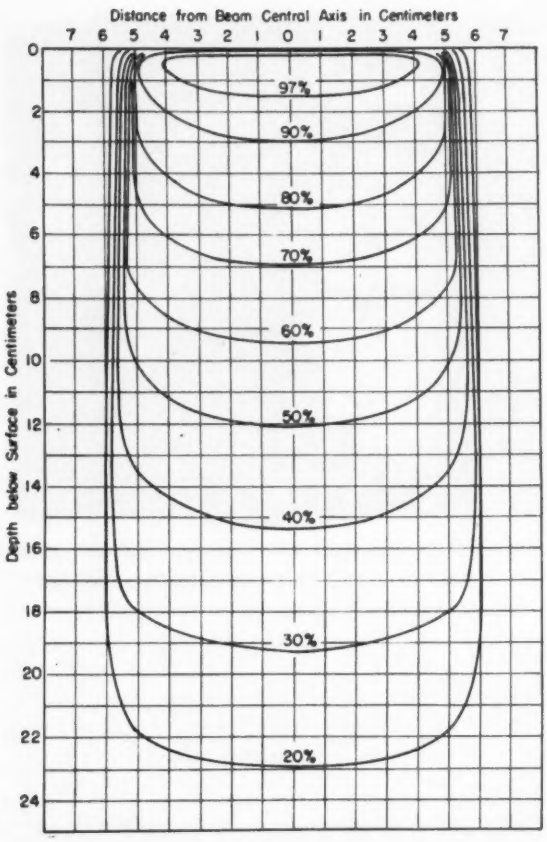


FIG. 2. Isodose depth dose curves for 2.0 mev. constant potential roentgen rays for 10 by 10 cm. field at 100 cm. target skin distance with filtration equivalent to 6.8 mm. of lead.

of the field always passes through the vertical axis of the rotating table.

Field Localization. High accuracy in the localization of the treatment beam upon the selected region is likewise a prerequisite to successful radiation therapy. The most convincing demonstration of accuracy is secured by roentgenographing the body section with the actual treatment field. It is fortunate that 2 million volt radiation has good and, in some regions of the body, even excellent diagnostic characteristics, particularly in distinguishing between air passages and soft tissue. Thus, the location of lesions within the bladder can be clearly discerned by introducing air and taking a 2 mev. roentgenogram. Usually, a double exposure film is taken in which the actual treatment field is superimposed upon a considerably larger field in order to bring out other locating features. Such a roentgenogram is shown in Figure 3 for a typical anteroposterior view of the pelvic section with the treatment field used in carcinoma of the cervix. Roentgenographic methods of demonstrating the accuracy of the position are used only in the first few days of treatment until sufficient corrected points of references have been secured to permit the routine repetition of the selected treatment. These films form an important part of the treatment routine, are helpful in improving the treatment plan and in calculating the resultant dose distribution.

STUDIES OF PELVIC DOSE DISTRIBUTION

To a considerable extent, the dose distribution secured within the pelvic region has been determined by photometric methods, making use of phantoms of anatomical shape. This photographic method of analysis is particularly effective for studying complex problems of dose distribution, and yields a quantitative answer for radia-

FIG. 3. Roentgenogram taken with 2 mev. radiation showing cervix treatment field superimposed on a large A-P background. Note the clarity with which the bladder can be delineated by the introduction of air.

tion in the supervoltage range.[2] Figure 4 shows a photographic film which had been sandwiched in a transverse abdominal section and irradiated rotationally by a 2 mev. roentgen-ray beam with the field shaped and positioned for treatment of carcinoma of the cervix. A 10 cm. wide posterior absorber was used in this study to reduce the dose in the immediately adjacent tissue. Figure 5 shows the resultant dose distribution obtained from this film. It can be seen that an essentially uniform tumor dose is delivered throughout the pelvic cavity, with the dose diminishing as one proceeds farther from the edge of the selected field. It is evident from the shape of the isodose lines that useful protection of the rectum can be secured by placing a suitable absorber immediately adjacent to the patient on the posterior side. Geometrical considerations will show that the use of such a posterior absorber provides protection greater than could be accomplished by turning off the roentgen-ray beam during some of the posterior angle of approach.

In Figure 6, the isodose distribution obtained with a 3 cm. wide posterior protector (the width of the steel table support) is compared with that resulting from the use of a 20 cm. wide protector. This comparison is made in a transverse plane passing through the middle of the pelvic field and is based on the use of similar treatment factors in all other respects. The 20 cm. wide absorber is seen to reduce the dose at the posterior side of the rectum from about 70 per cent to 40 per cent of the axis dose. On the anterior side of the rectum, the wider protector reduces the dose by about 10 per cent. Although the 20 cm. wide posterior absorber provides greater protective effect, we are inclined at present toward the routine use of the intermediate width of 10 cm. It may be noticed also that this protective technique causes the isodose curves to spread laterally and that a narrowing of the treatment field is thereby made permissible. Although the protection afforded to the rectum does introduce some increase in the dose to the femoral head and neck, the total body dose is actually reduced by this procedure if the field is narrowed to compensate for the lateral spread.

Examination of Figures 5 and 6 shows

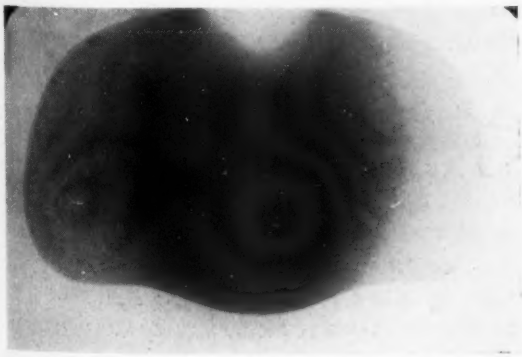


Fig. 4. Film sandwiched in the abdominal section of a masonite phantom and exposed rotationally to a 2 mev. roentgen-ray beam with a 13 cm. circular field at the axis of rotation 125 cm. from the target. Note protection afforded by a 10 cm. wide posterior protector.

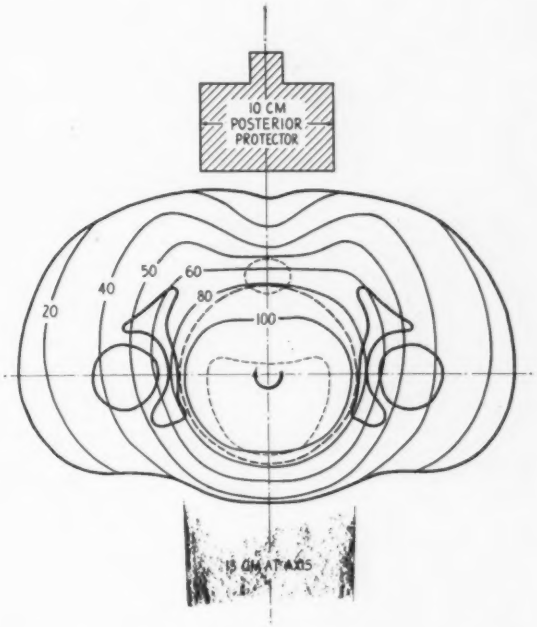


Fig. 5. Dose distribution obtained in rotational treatment of cervix with 2 mev. roentgen rays. Field width 13 cm. at axis of rotation which is 125 cm. from the target; 10 cm. wide posterior protector.

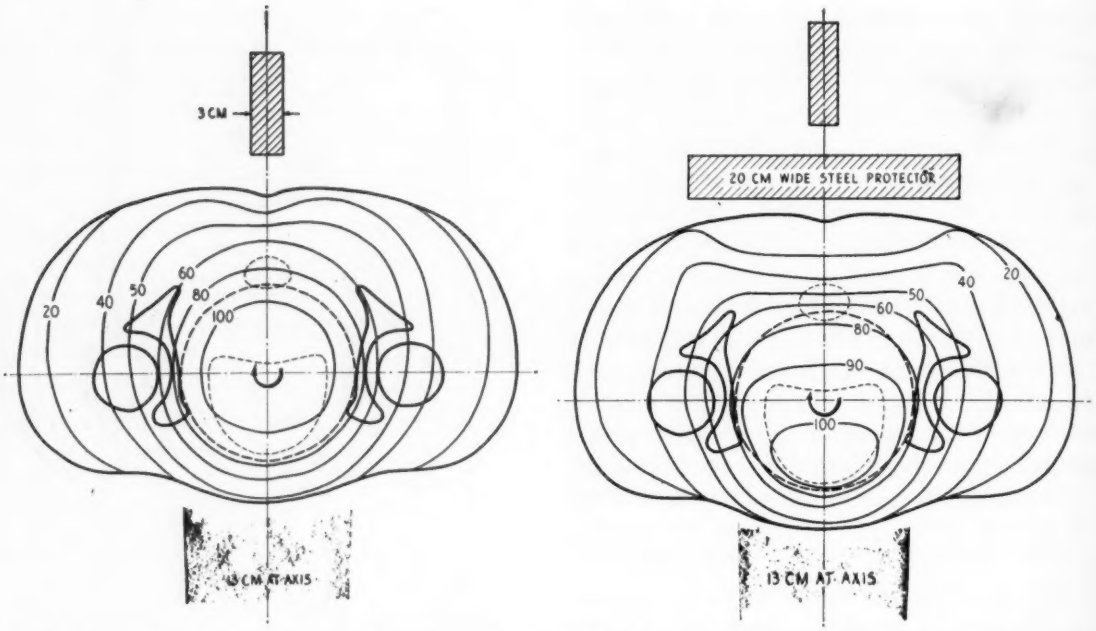


Fig. 6. Comparison of dose distributions obtained of the pelvic cavity with 2 mev. rotational roentgen therapy using (*A*) a 3 cm. wide posterior protector, and (*B*) a 20 cm. wide posterior protector. Field width at axis is 13 cm., target to axis of rotation distance is 125 cm.

that the dose sustained at the head of the femur is between 40 and 60 per cent. The dose at the level of the femoral neck is estimated at about 45 per cent of the axis tissue dose. From the point of view of conventional roentgen therapy, these resultant doses to the weight-bearing bones would appear high. It is probable, however, that the biological doses are less than those which have been safely delivered with 200 kv. roentgen rays, and so far, the complete absence of evidence of damage seems to support this belief. It has been shown by Spiers[5] and Wilson[7] that the ionization energy absorbed by bone traversed by gamma radiation is about one-half that which would be locally absorbed from a 200 kv. beam of corresponding intensity. This fortunate characteristic of supervoltage radiation to avoid excessive irradiation of bony tissue is due to the almost complete absence of photoelectric absorption which depends upon the fourth power of the atomic number. Two million volt radiation is in the broad energy range dominated by the Compton absorption process which depends primarily on the density of the tissue traversed. This also accounts for the very small contrast in supervoltage roentgenograms between soft tissue and bony structures and the relatively large contrast between soft tissues and air passages, factors which can be exploited in the diagnostic examination of such bone-covered regions as the lung and the mediastinum.

CLINICAL PROCEDURES

The treatment plan for cancer of the cervix and bladder has included the delivery of a tumor dose of 6,000 roentgens in a total of thirty-five treatment days for an elapsed time of about seven weeks at the rate of 170 r per treatment. Although we realize that tumor sensitivity varies considerably between individuals as well as between tumor types, nevertheless, at the present time, we follow the plan of delivering a uniform dose of 6,000 r in about seven weeks to all epidermoid types of malignancies. The field shape has commonly been a 12 to 14 cm. circle which has been

trimmed at its sides to a 10 to 12 cm. width just sufficient to lie within the bony structure. The rotational administration of such a dose to a typical patient delivers a total body dose of approximately 20 million gram roentgens and a total tumor dose of approximately 6 million gram roentgens.

Most patients have tolerated this treatment with only moderate reaction. The blood changes have not been significant. In no case has there been a significant change in the hematological picture.

Diarrhea has been a problem in some cases, usually during the latter part of and the first two to three weeks following treatment. In no case have we noted damage to the rectum unless the patient had previous radium treatment several months or years before 2 mev. therapy.

In all cases in which radiation therapy is given, especially when large quantities are administered, it is imperative to employ all supportive treatment necessary to keep the patient in good condition. Antibiotics are used when necessary to avoid infection, an effort is made to maintain nutritional requirements, and good hygienic and rest measures are urged.

In about 30 per cent of the cases it has been necessary to allow a two or three week interruption in treatment, but these patients have generally completed their treatment of 6,000 roentgens in excellent condition.

The type of tumors of the cervix treated so far are summarized in Table I by stage, class, and follow-up. The follow-up study of infiltrating cancers of the bladder treated thus far is summarized in Table II. Although the results appear favorable, the elapsed time is insufficient to permit a quantitative appraisal of the efficacy of this form of treatment.

It is noted from the table showing the initial results of treatment of deep, infiltrating carcinoma of the urinary bladder that of 22 patients who received treatment at least six months before these cases were charted, 20 were in sufficiently good condition to complete the series. Of the 20, 8 patients have died of their disease, and 1 of perforation of the intestine. In this case no malignancy was found at postmortem examination. Eleven patients are

Table I

SUMMARY OF CASES OF CARCINOMA OF THE CERVIX UTERI TREATED AT MASSACHUSETTS INSTITUTE OF TECHNOLOGY FROM DECEMBER 24, 1949 TO MAY 1, 1952

		Patients			Clinically Symptom-free Months		
		Total No.	Failures		0–6	0–12	12–24
			Recurrence	Dead			
Stage I	A	2	1			1	
	B						
Stage II	A	4			2	1	1
	B	7		1	4	2	
Stage III	A	2		1		1	
	B	6		1	3	2	
Stage IV	A						
	B	1			1		
Cervical stump	B	3		1		2	
Total		25	1	4	10	9	1

TABLE II

SUMMARY OF CASES OF CARCINOMA OF BLADDER TREATED AT MASSACHUSETTS INSTITUTE OF TECHNOLOGY FROM JANUARY, 1950, TO SEPTEMBER 1, 1952

Case	Sex	Age, years	Date of Treatment	Cell Study	Cystoscopic Examination	Symptoms		Results
						Objective	Subjective	
Clinically Free of Disease								
1	M	63	1/ 3/51	Neg.	Neg.	Bleeding	0	Good
2	M	69	12/ 5/50	—	Granulations	Bleeding	0	Cystectomy; no carcinoma
3	M	69	11/ 2/50	—	Neg.	0	0	Good
4	M	55	1/ 3/52	Neg.	—	0	0	Good
5	M	64	12/27/50	Neg.	—	—	—	Good
6	F	70	4/18/51	Neg.	Neg. roentgenograms	0	Burning	Good
7	M	64	3/ 6/50	—	—	—	—	Good
8	M	31	6/13/50	—	Neg.	0	—	Good
9	M	60	2/27/50	—	Neg.	0	—	Good
10	M	48	3/29/50	—	Granulations	Bleeding	Burning	Good*
Persistent or Metastatic Disease								
11	M	78	9/18/51	Pos.	Pos.	Bleeding	Burning	Died
12	M	66	10/ 3/50	Pos.	—	Bleeding	Burning	Died
13	M	74	12/26/50	Pos.	Pos.	Bleeding	—	Died; 2 series roentgen therapy; cancer at autopsy
14	F	72	11/15/50	—	—	Edema; bleeding	—	Died
15	M	60	2/11/52	Neg.	Neg.	0	0	Died; bone metastases
16	M	50	11/13/51	Pos.	—	Pos.	—	Died; fibrosarcoma
17	M	67	1/16/50	—	Pos.	Pos.	—	Died
18	F	67	8/21/51	Neg.	—	0	—	Died; uremia
19	M	52	1/24/52	Pos.	Pos. biopsy	0	0	Persistent
20	F	69	5/14/51	—	Pos. biopsy	0	0	Persistent

* Case 10 died of perforation of bowel.

symptom-free, but in 2 of these 11 cases there is still biopsy proof of cancer. Nine patients had either negative cystoscopic studies or repeatedly negative Papanicolaou smears. All except 2 of those dead of the disease were over seventy years of age and most of them had had previous operation or irradiation. In 1 patient, sixty-nine years of age, bleeding continued following treatment. A cystectomy revealed no residual malignant disease.

Several factors which are important to prognosis can be gained from this series. One is that the response of tumor and surrounding tissue is not favorable in arteriosclerotic patients, since in several cases bleeding apparently was due to fragility of the capillaries.

Response has not been as satisfactory when infection was present and uncontrolled during the period of irradiation, the resulting mucosa being hypertrophied and showing a tendency to bleed even though no tumor can be demonstrated by cystoscopic or biopsy studies.

In order to determine the adequacy of

the radiation dose and also to obtain some clue as to the radiosensitivity of the patient, cell study smears are taken throughout the course of treatment.* An attempt is being made to use as a prognostic point the correlation of the effect of our selected tumor dose of 6,000 roentgens in thirty-five treatment days with the reaction of either the tumor or the surrounding normal cells and, although it is too early, it seems possible that such a correlation may be found to exist. Local persistence in 3 cases of cancer of the cervix and 2 cases of cancer of the bladder has led us to re-examine the adequacy of 6,000 roentgens as a tumor dose and to compare it with the far higher levels commonly delivered by radium implantation. We are inclined to believe that certain cases will require more than 6,000 r in thirty-five days to heal the primary lesion. If this is true, we may add 2,000 r to the primary lesion through a small port, given concomitantly with the radiation through the larger port so as to keep the time interval the same. In this plan the 170 r will be delivered daily to the large spherical region as before, but followed by an additional 60 r through a smaller port centered on the primary lesion.

It would be especially helpful if a reliable index of radiosensitivity, such as that proposed by Ruth M. Graham[1] (of Massachusetts General Hospital) were available.

CONCLUSION

We have briefly described the rotational plan of 2 mev. roentgen therapy for pelvic tumors. Many of the patients treated have had advanced disease and the results thus far have been most gratifying. With more experience and with treatment of earlier cancers, the percentage of patients showing primary healing should improve.

J. G. Trump, Sc.D.
Department of Electrical Engineering
Massachusetts Institute of Technology
Cambridge 39, Massachusetts

* Smears are analyzed by Miss M. Middleton of the New England Deaconess Hospital and Ruth M. Graham of the Massachusetts General Hospital.

The authors gratefully acknowledge the support of this work by the American Cancer Society and the Godfrey M. Hyams Trust.

REFERENCES

1. GRAHAM, R. M. Prognosis of cancer of cervix by vaginal smears; correlation with five year results. *Surg., Gynec. & Obst.*, 1951, *93*, 767–774.
2. GRANKE, R. C., WRIGHT, K. A., EVANS, W. W., NELSON, J. E., and TRUMP, J. G. Film method of tissue dose studies with 2.0 mev. roentgen rays. AM. J. ROENTGENOL., RAD. THERAPY & NUCLEAR MED., August, 1954, *72*, 302–307.
3. JEWETT, H. J. Carcinoma of bladder: influence of depth of infiltration on 5-year results following complete extirpation of primary growth. *J. Urol.*, 1952, *67*, 672–676.
4. RICHARDS, G. E. Analysis of technical factors and results of treatment in carcinoma of cervix uteri; description of improved radium applicator. AM. J. ROENTGENOL. & RAD. THERAPY, 1947, *58*, 783–797.
5. SPIERS, F. W. Effective atomic number and energy absorption in tissues. *Brit. J. Radiol.*, 1946, *19*, 52–63.
6. TRUMP, J. G., WRIGHT, K. A., HARE, H. F., and LIPPINCOTT, S. W., JR. Two million volt roentgen therapy using rotation. AM. J. ROENTGENOL. & RAD. THERAPY, 1951, *66*, 613–623.
7. WILSON, C. W. Dosage of high voltage radiation within bone and its possible significance for radiation therapy. *Brit. J. Radiol.*, 1950, *23*, 92–100.

DISCUSSION

DR. T. LEUCUTIA, Detroit, Michigan. The problem of efficient distribution of the radiation in treating malignant neoplasms located within the pelvis is one which has preoccupied radiotherapists from the earliest days. The introduction of deep roentgen therapy with 200 kv., the employment of multiple fields for crossfiring, the supplementation of deep roentgen therapy with intracavitary radium applications whenever feasible, and lately the increasingly more extensive use of supervoltage and megavoltage roentgen therapy, cobalt and radium beam therapy and other source therapy have been important steps undertaken in rapid succession with the aim of improving the distribution of the various types of rays within the contemplated volume of irradiation and thereby increasing their efficacy on the neoplasm.

Unfortunately, the anatomic shape of the pelvis and the great individual variation of its configuration are factors which complicate the

issue to no small extent. Although the lesions located in the center of the pelvis cannot, as a rule, be treated with very satisfactory results, those situated away from the center and especially the peripheric extensions from more advanced central malignant neoplasms are in many instances irradiated inadequately, regardless of which method is used.

In this respect, the valuable contribution of Drs. Hare and Trump represents another important step in the forward direction. These investigators have assiduously studied the many technical difficulties which had to be overcome and have elaborated a method which, as shown here today, can be used to definitely improve the uniformity of the distribution of the irradiation in the various off-center regions of the pelvis. Preliminary clinical trial seems to indicate that the practical results obtained are commensurate with the improvement of the physical factors involved.

The paper is well conceived and excellently prepared. I am most grateful for having been asked to discuss it.

Vol. 72, No. 2

THE RANGE OF USEFULNESS OF PHOTOGRAPHIC FILM IN ROENTGEN DOSIMETRY*†

By GERALD J. HINE, Ph.D.‡

Department of Physics and Radioactivity Center of the Laboratory for Nuclear Science, Massachusetts Institute of Technology

CAMBRIDGE, MASSACHUSETTS

I. INTRODUCTION

HIGH energy roentgen and gamma radiation has been applied recently to an increasing variety of problems of a physical, industrial, and medical nature. The necessary measurements involved in these problems are made by using one or several of the three basic types of radiation detectors —ionization chambers, pulse counters, and photographic film. Great efforts are being made to explore and to expand the effiency of each type of radiation detector, and special attention is being given to the investigation of their usefulness as dosage indicators.

Under various experimental conditions, the photographic emulsion is the most convenient radiation detector. Photographic film has the advantage of indicating local variations of the radiation intensity while at the same time recording the over-all intensity of a large area. Due to its small mass and size, film does not disturb the intensity distribution of roentgen or gamma radiation significantly. Furthermore, film records the radiation flux over any time interval from a fraction of a second to several days or weeks. The film sensitivity however, varies with the radiation energy; therefore, the film response is not a simple function of the radiation dose. Some of the problems connected with the application of photographic film for dosage measurements will be discussed.

II. PHOTOGRAPHIC FILM DENSITY

The developed film which had been exposed to radiation will show a certain amount of blackening. The latter can be determined by the amount of light absorbed from a light beam incident on the developed film. The negative of the common logarithm of the fractional transmission of white light through the processed film is called the photographic density D. That means, a film with a photographic density of $D=2$ transmits only $1/100$ of the incident white light. The density variation over the film area is the only information which can be obtained from an exposed film. The energy and character of the radiation which has caused the observed density cannot be recognized.

The instruments available for measuring photographic film densities are called *densitometers*. None of the commercial instruments are built for scanning a large film area and simultaneous recording of the observed density distribution. Several depart ments of radiology* have developed their own instruments,[5] with which the regions of constant photographic density can be outlined by isodensity lines which separate areas of varying film density.

A roentgen film developed without previous exposure has an inherent "fog density" of $D=0.2$ to $D=0.3$. This includes a density of about $D=0.1$ for the celluloid film base which supports the emulsion. The additional fog in the emulsion depends on the film type, its age, and the method of development.

When developing roentgen films for dosimetry purposes, great care should be taken to standardize and control the developing procedure.[2,12] The developing time

* Radiotherapy Department, Hospital for Joint Diseases, New York, New York.

* Read by title at the Thirty-fourth Annual Meeting, American Radium Society, Chicago, Ill., June 8–10, 1952.
† This work has been assisted by AEC Contract AT(30-1)-1952.
‡ At present with Radioisotope Unit, Boston Veterans Administration Hospital, Boston, Massachusetts.

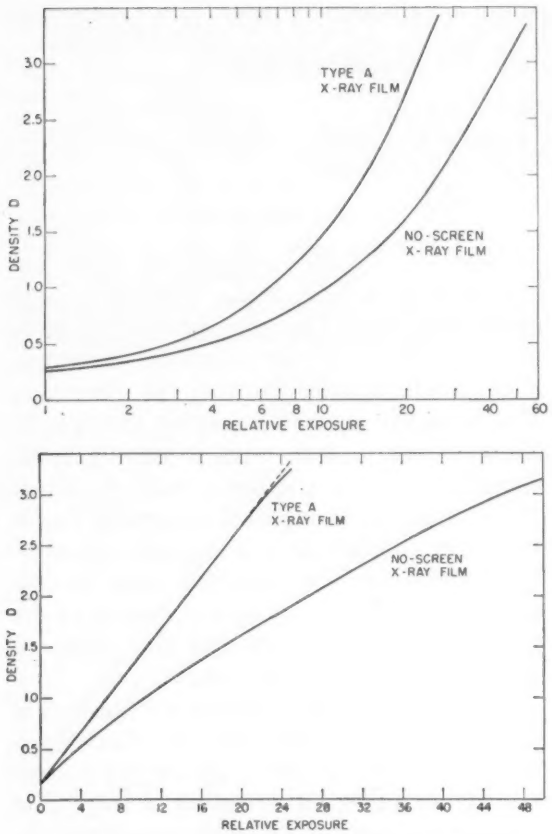


Fig. 1. Increase in density *vs.* relative exposure for Eastman Kodak No-Screen and Type A X-Ray Films: (*a*) H and D curve, (*b*) linear plot.

is a function of the temperature of the developer and should not be less than five minutes at standard temperature; the developer has to be renewed regularly, and the film should be developed under frequent agitation.

The film response to exposures of increasing radiation intensities is commonly expressed in terms of the "characteristic curve" or "H and D curve" (Hurter and Driffield*). This is a plot of the photographic density of the developed film *vs.* the common logarithm of the relative exposure (radiation intensity × time). The shape of the characteristic curve of a certain film emulsion exposed to roentgen rays of different qualities is the same for a wide range of roentgen-ray energies. Figure 1*a* shows the H and D curve for Kodak No-Screen and Type A emulsions obtained with standard developing technique.[2,12] If for any given film type the fundamental dose-density relation is known, the variation of the exposure over the film area can be obtained from the measured film density distribution.

For Kodak industrial Type A film, a *linear* dose-density relation has been observed by several authors.[2,8,11,12] In Figure 1*b*, the density is plotted *vs.* the film exposure on a linear scale for Eastman Kodak No-Screen and Type A X-Ray Film. While the H and D curves for these two types of emulsions have a similar appearance (Fig. 1*a*), only Type A film shows a linear dose-density relation over a wide range of densities (Fig. 1*b*). For Type A film, O'Connor[12] found a linear response up to a "net" density (total minus fog density) of $D = 2.5$ with 400 kev. and 2 mev. constant potential roentgen rays. The same linearity has been observed by the author[8] with 2 and 3 mev. constant potential roentgen rays, and by Laughlin and Davies[11] with 25 mev. betatron roentgen rays. Finally, Dudley,[2] exposing Type A film to monoenergetic electrons of various energy (70 kev. to 1.6 mev.), found a linear relation between exposure and photographic density up to a net density of $D = 3.5$ for all energies of the incident electrons.

Since the H and D curve (Fig. 1*a*) and the linear plot (Fig. 1*b*) give the same information, both can be used to correlate film exposure and photographic density. The H and D curve is particularly useful if the exposure covers a wide range of intensities. However, in the case of Type A film, the linear plot has the great advantage that the film sensitivity can be determined from a single calibration exposure. For any H and D curve, and also for a nonlinear dose-density relation (No-Screen X-Ray Film, Fig. 1*b*), the film has to be calibrated by a series of exposures of known relative intensity.

The observed film density depends only on the roentgen-ray dose delivered to the

* Hurter and Driffield, *J. Soc. Chem. Ind.*, 1890, *9*, 455.

film and not on the dose rate. This so-called "reciprocity law" is well established for roentgen rays and electrons as incident radiation.

It will be shown below that for high energy roentgen or gamma rays, the material surrounding the film may act as an intensifier. Therefore, all calibration exposures have to be made under the same conditions as those existing when the film is used for dosage measurements. Special attention has to be given to the energy spectrum of the radiation used for calibration and for dose measurements. The dose-density relation for a certain film emulsion is the same, regardless of the quality of the incident radiation. However, the dose required to produce a given photographic density can vary with the radiation energy. Therefore, the characteristic curves can be used only to compare the relative exposures obtained with radiation of the same quality.

Since, as shown below, the exposure to roentgen or gamma radiation is caused by secondary electrons, some information must first be gained concerning the film response to electrons.

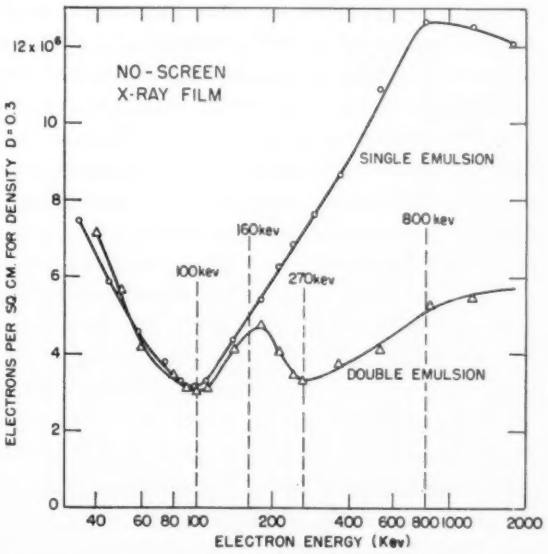


Fig. 2. Number of electrons per sq. cm. producing a net film density of $D=0.3$ *vs.* energy of monoenergetic electrons incident perpendicularly on Eastman Kodak No-Screen film. (From beta-ray spectrometer studies by Dudley.[2]) The variation of ion density and range of the electrons with increasing energy produces the observed film response.

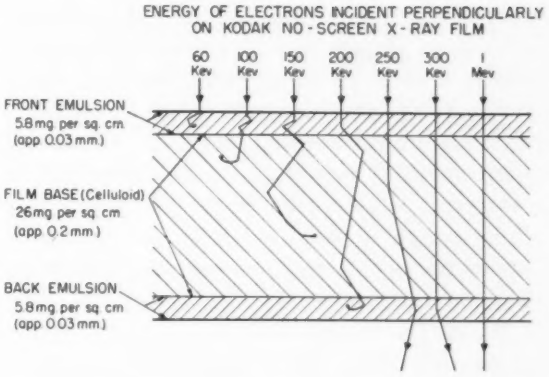


Fig. 3. Electrons of different energy incident perpendicularly on double emulsion film. Low energy electrons with small ranges are scattered highly within the emulsion activating a maximum number of silver grains. High energy electrons losing a fixed amount of energy independent of their initial energy within the emulsion show only few deflections from a straight path.

III. Film Response to Electrons

The sensitivity of a particular type of film to electrons (primary and secondary) depends on several variables such as the electron energy, the angle of incidence, and the developing conditions.[2] Dudley[2] has determined the variation of the film response to monoenergetic electrons of different energies incident perpendicularly on Eastman Kodak No-Screen X-Ray Film (Fig. 2). The number of electrons per sq. cm. required to produce a given net density ($D=0.3$) is plotted in Figure 2 as a function of the energy of the incident electrons. The results of Figure 2 have been obtained by Dudley,[2] using the following method. By magnetic deflection of the beta rays emitted from a radioactive source, monoenergetic electrons are extracted from the continuous beta-ray spectrum. Monoenergetic electrons of a given energy are focused first on an end-window proportional counter for quantitative measurements, and then on a film for comparative densitometry.

In order to explain the shape of the

curves given in Figure 2, the illustration shown in Figure 3 will be used. Figure 3 shows a cross section of the film with electrons of different energy incident perpendicularly on its front surface. Electrons with energies less than 60 kev. are highly scattered within the front emulsion, and their range is smaller than the emulsion thickness of 5.8 mg. per sq. cm. Electrons with an initial energy up to 100 kev. are diffusely scattered as they penetrate the front emulsion. They lose most of their energy within the emulsion and are therefore very effective for the exposure. Therefore, at low electron energies, the number of electrons necessary to produce a given density decreases with increasing electron energy from 30 to 100 kev. (Fig. 2). The single emulsion curve of Figure 2 has been obtained by removing the emulsion on the back surface.

Monoenergetic electrons of 150 kev. energy have a range of 27 mg. per sq. cm. and therefore cannot reach the back emulsion. Only electrons with energies above 160 kev. can penetrate about 31.8 mg. per sq. cm. of material to reach the back emulsion. Therefore, the single and double emulsion curves coincide up to electron energies of 160 kev. (Fig. 2).

Electrons with an energy of 200 kev. (range 43 mg. per sq. cm.) lose practically all their energy before emerging from the film base (Fig. 3). Only electrons with energies above 270 kev. have ranges large in comparison with the film thickness. However, due to scattering within both emulsions and the film base, a large fraction of all electrons with 270 kev. initial energy is nearly completely absorbed within the double emulsion film. Therefore, the double emulsion curve in Figure 2 shows a second minimum for about 270 kev. electrons. That means, with increasing electron energy from 160 to 270 kev., a decreasing number of incident electrons will produce the same photographic density.

High energy electrons show very little scattering, and therefore the linear path of the electrons through the film becomes equal to the film thickness (Fig. 3). With decreasing path length within the emulsion, the number of silver grains activated by a single electron passing through the emulsion is reduced. Furthermore, the ion density per path length, which decreases with increasing electron energy becomes nearly constant for electrons with energies above 800 kev. Therefore, the number of electrons required for a given film density still increases as the electron energy rises from 270 to 800 kev. (Fig. 2). Finally, all high energy electrons having a constant ion density and a range large in comparison with the total film thickness lose the same amount of energy while passing through the film, regardless of their actual energy.[8] The film sensitivity for high energy electrons is, therefore, rather constant and proportional to the emulsion thickness.

The above data will now be discussed in terms of tissue dosage. The curves shown in Figure 2, which appear to be rather complex, can be qualitatively understood by following the above discussion. The number of electrons incident on the film has been determined experimentally. The tissue dose resulting from such an exposure can be calculated, since the rate of energy loss for electrons in tissue is known as a function of the initial electron energy. Electrons of 1–2 mev. energy show a minimum rate of energy loss (minimum ionization) in water of 2.90×10^{-6} ergs per gm. per sq. cm., or about 3×10^{-8} rep per 1 cm. path in water. Electrons with an initial energy of 100 kev. lose 2.3 times as much energy for the same path length. Finally, the surface tissue dose from incident electrons of all energies will be increased by about 25 per cent due to electrons backscattered from deeper tissue layers towards the surface. This correction has been applied on the conversion from electrons per sq. cm. to tissue dose in ergs per gm. In Figure 4, the surface exposure producing a photographic net density of $D = 0.3$ is shown as a function of energy of the perpendicularly incident electrons for several film emulsions. For the curves on the left side, the surface exposure is given

in number of electrons incident per sq. cm., while for the curves on the right side the radiation dose is expressed in ergs per gram. The left side curves for No-Screen X-Ray Film in Figure 4 are the same as those shown in Figure 2. From Figure 4, it is evident that the Type A, N.T.B., and Cine positive emulsions are considerably less sensitive for electrons of all energies in comparison with the No-Screen emulsion. However, all emulsions are relatively more sensitive to low energy than to high energy electrons for the reasons outlined above for the No-Screen emulsion.

Type A double emulsion film exposed to high energy electrons requires a dose of about 100 ergs per gm. (Fig. 4) for a photographic net density of $D=0.3$. Since the useful range of photographic density extends from about $D=0.3$ to $D=3$, this means that a dose of 1 to 10 rep is required for this type of emulsion.

In general, electrons emitted from various types of sources will not strike the film surface perpendicularly. For diffuse incidence the curves shown in Figures 2 and 3 are changed slightly, due to a variation of the path length of the electrons in the emulsion depending on their angle of incidence.[2]

The information given above concerning the action of electrons as primary radiation should be sufficient for a discussion of the film response to roentgen or gamma rays as incident radiation.

IV. FILM RESPONSE TO THE SECONDARY ELECTRONS PRODUCED BY ROENTGEN AND GAMMA RADIATION

While roentgen rays always have a continuous energy spectrum (heterogeneous radiation), beta rays emitted from various radioactive isotopes (radionuclides) show discrete, monoenergetic lines. If roentgen or gamma rays are incident on matter of finite thickness, a certain percentage of the primary radiation will penetrate the material without being absorbed. The absorbed fraction produces secondary electrons inside the material. Their action on

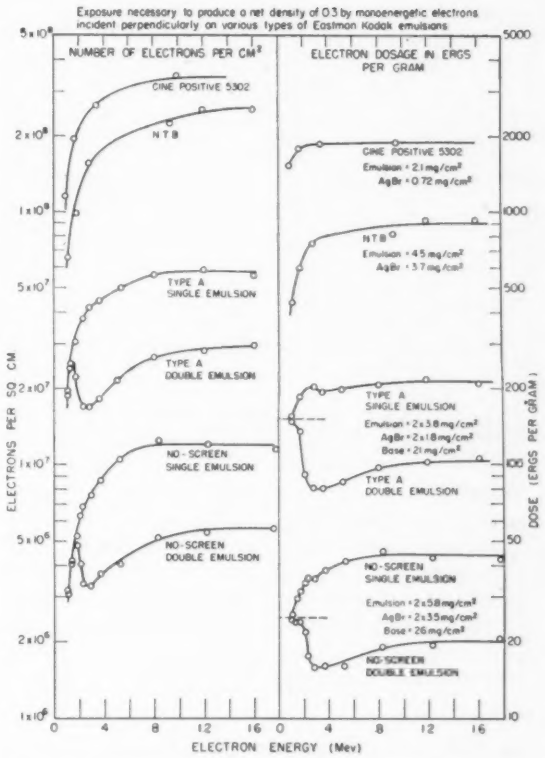

Exposure necessary to produce a net density of 0.3 by monoenergetic electrons incident perpendicularly on various types of Eastman Kodak emulsions
NUMBER OF ELECTRONS PER CM²
ELECTRON DOSAGE IN ERGS PER GRAM
ELECTRONS PER SQ CM
DOSE (ERGS PER GRAM)
ELECTRON ENERGY (Mev)
CINE POSITIVE 5302
N T B
TYPE A SINGLE EMULSION
TYPE A DOUBLE EMULSION
NO-SCREEN SINGLE EMULSION
NO-SCREEN DOUBLE EMULSION
CINE POSITIVE 5302 Emulsion • 2.1 mg/cm² AgBr • 0.72 mg/cm²
N T B Emulsion • 4.5 mg/cm² AgBr • 3.7 mg/cm²
TYPE A SINGLE EMULSION Emulsion • 2x3.8 mg/cm² AgBr • 2x1.8 mg/cm² Base • 2.1 mg/cm²
TYPE A DOUBLE EMULSION
NO-SCREEN SINGLE EMULSION Emulsion • 2x5.8 mg/cm² AgBr • 2x3.5 mg/cm² Base • 2.6 mg/cm²
NO-SCREEN DOUBLE EMULSION

FIG. 4. Film surface exposure (electrons per sq. cm. or ergs per gram) for a photographic net density of $D=0.3$ produced by monoenergetic electrons incident perpendicularly on various types of Eastman Kodak emulsions. (From beta-ray spectrometer studies by Dudley[2].)

matter or any kind of radiation detector is the only indication concerning the presence of roentgen or gamma radiation.*

The absorption of a gamma ray within a given material depends strongly on its atomic composition and the energy of the incident radiation. The latter also determines the maximum energies of the secondary electrons at the beginning of their paths. The various types of gamma-ray absorption processes have been described frequently, but the emission of the secondary electrons following each gamma-ray interaction has been studied in much less detail.[1,10] The absorption of roentgen and gamma rays in the photographic film and the production of secondary electrons in

* Since the ionizing electrons appear only after the absorption of a roentgen or gamma ray, the latter should be called "non-ionizing" radiation.

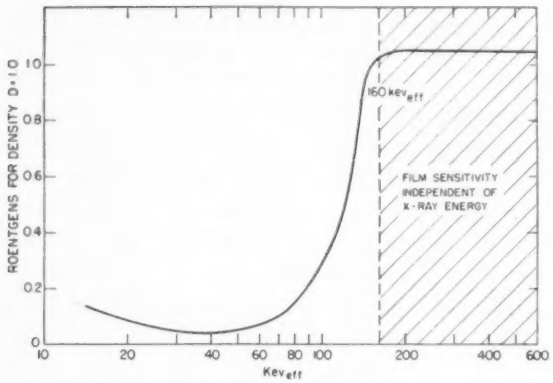


Fig. 5. Exposure in roentgens which produces a photographic density of $D=1.0$ (including fog density) with Eastman Kodak Blue Brand X-Ray Film *vs.* effective energy for heavily filtered roentgen rays. With increasing roentgen-ray energy, the photoelectric absorption within the emulsion decreases and the range of the recoil electrons increases. For high energy roentgen rays, the film sensitivity becomes constant, since the production of recoil electrons and their ion density is rather energy independent.

the film and the materials adjacent to the emulsion will be discussed qualitatively.

Low energy roentgen rays are strongly absorbed by their photoelectric interaction with the high atomic number elements (Ag and Br) in the photographic emulsion. The range of the secondary electrons produced by 50 kev. roentgen rays is so small that they can ionize only the "neighboring" atoms for a distance which is only a fraction of the emulsion thickness. Therefore, the secondary electrons produced by low energy roentgen rays are not as effective for the film exposure as those originated by higher energy radiation. However, with increasing roentgen-ray energy the photoelectric absorption within the emulsion diminishes rapidly. The variation of the film sensitivity with the energy of the incident radiation is the result of these two competitive processes; thereby with inincreasing energy the secondary electrons become more effective, but their production diminishes. Using Eastman Kodak Medical X-Ray Film, Wilsey[18] has determined the film sensitivity as a function of the effective energy* (kev.$_{eff.}$) for heavily filtered roentgen rays (Fig. 5). The results show that, in order to get a constant film density, the radiation dose has to be increased by a factor of about 20, when going from 40 to 160 kev.$_{eff.}$ roentgen rays. Since this is the energy range of the "conventional" roentgen therapy machines (180–250 kv., peak), film is not suitable for dosimetry work with "conventional" roentgen rays. The spectral energy distribution of the roentgen rays changes with the amount of filtration (tissue depth) and therefore the film sensitivity is not a constant.

For gamma rays with energies above 300 kev. or heavily filtered roentgen rays of more than 400 kv. (peak), the film sensitivity becomes independent of the energy of the incident radiation. At these energies the photoelectric absorption by the AgBr is negligible, and the Compton absorption predominates. The production of recoil electrons by the Compton process is nearly independent of the energy of the incident radiation, and the range of the secondary electrons is so large that only a small portion of their total energy is expended in the film itself (Fig. 3). Therefore, for "high energy" radiation, the film sensitivity varies insignificantly with the radiation energy (Fig. 5).

A second physical change occurs with increasing energy of the incident gamma rays that is often not recognized. The recoil electrons are formed not only in the film material, but also in the matter adjacent to the film. A film exposed to gamma rays is always covered by a light-tight film holder in addition to the air volume between source and film. This mass of material surrounding the film can amount to several times that of the film itself. Therefore, the number of secondary electrons produced by high energy gamma rays in the film is small compared with those emitted from the materials covering the film. This has been demonstrated by Harrington *et al.*[7] who

* The effective energy for roentgen rays depends not only on the peak voltage and the wave form, but also on other factors such as filtration. However, within wide limits, the effective roentgen-ray energy may be assumed to be 0.5–0.8 of the peak voltage, if no half-value layer data are available.

exposed Kodak No-Screen film, covered on both sides with thin lead foils, to the radium gamma rays in an evacuated apparatus. By magnetic deflection they prevented the film from being exposed to the secondary electrons emitted from the walls of the apparatus after the lead foils had been removed. By this experiment, Harrington *et al.*[7] demonstrated that the film exposure due to the secondary electrons produced within the film is only 4 per cent of the total exposure of the film covered by the lead foils. It is well known that lead foil can be used as intensifying screen for films exposed to roentgen radiation. However, for high energy gamma rays (above 1 mev.) the secondary electron emission from lead is not much greater than from a low atomic number material.[9] Therefore, the above result is correct for film covered by any material. The roentgen or gamma rays absorbed in the film itself produce only a small fraction of the observed film density. If film exposed to high energy roentgen or gamma rays is covered by a "tissue equivalent" material, the photographic density is proportional to the radiation dose and independent of radiation energy.[8]

Finally, the contribution of the high energy secondary electrons emitted from material on both sides of the film depends on the angle of incidence of the primary radiation.[6] Since high energy secondary electrons are emitted mainly in the forward direction, all electrons produced by perpendicularly incident gamma rays should leave the absorber through its back surface. However, this is true only for low atomic number media such as carbon, lucite or other plastics. With increasing atomic number of the absorbers the electrons are scattered more and more in all directions before they leave the medium. In the case of lead, about half of the electrons are scattered backward so that nearly the same number of electrons is emitted from each surface of a lead foil.[9] Figure 6 shows this information in some detail. The ratio of forward to backward emission of secondary electrons is plotted as a function of the primary gamma-ray energy for Al, Cu, Sn, and Pb absorbers. With increasing gamma-ray energy, a greater fraction of secondary electrons is emitted from the rear of the absorber because the direction of emission of the secondary electrons inside the absorber tends to approximate the direction of the primary gamma rays. From Figure 6 it is obvious that the backscattering diminishes with decreasing atomic number of the secondary electron emitter. For carbon, the ratio could not be determined, since practically no secondary electrons leave the front surface of the absorber. An aluminum absorber irradiated with 1 mev. gamma rays (Fig. 6) emits six times as many secondary electrons in the forward direction as in the backward direction. Lead, under the same conditions, emits the same number of secondary electrons in both directions.

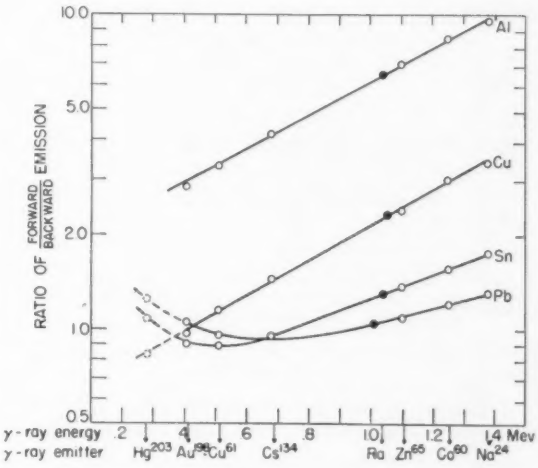


Fig. 6. Ratio of forward to backward emission of secondary electrons from various absorbers as a function of the energy of the incident gamma rays;[9] absorber thickness equal to the maximum range of the secondary electrons. With increasing energy of the incident radiation, fewer secondary electrons are scattered backwards, if the absorber consists of low atomic number elements. Within a lead absorber, the electrons are scattered rather independent of their energy towards all directions.

From this discussion, it follows that for high energy gamma rays lead will act as a good intensifier, if the *rear* of the film is covered by a lead foil. The front surface,

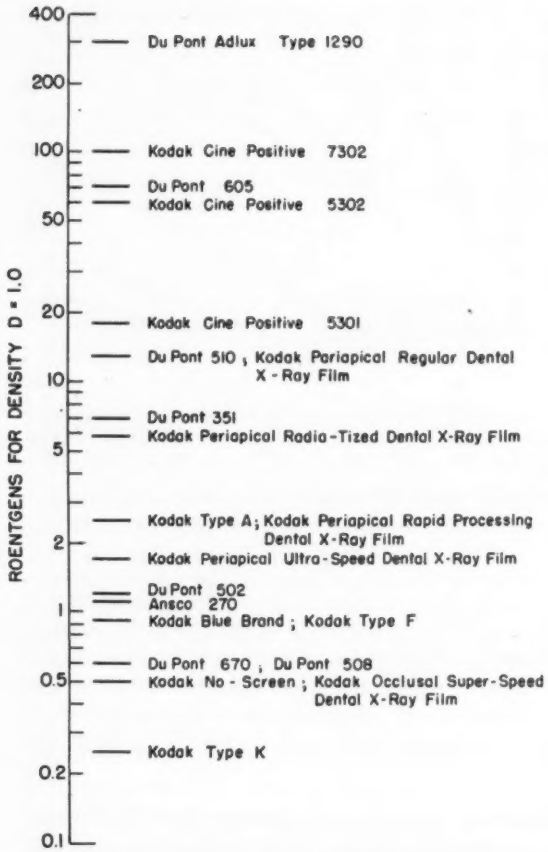


Fig. 7. Exposure in roentgens by high energy roentgen or gamma rays which produces a photographic density of $D=1.0$ (including fog density) for different types of roentgen-ray emulsions.

however, should be covered by a material of low atomic number (cardboard) in order to obtain a maximum intensifying action.

V. Conclusions Concerning Roentgen Dosimetry

1. Two factors contribute to the spectral film sensitivity of roentgen or gamma rays.
   (a) The response of film to electrons of various energies, and
   (b) The production of secondary electrons by roentgen or gamma rays in the film itself or in the matter adjacent to the film.

2. The film response to low energy gamma rays with energies up to 300 kev. depends on the absorption of the radiation within the emulsion. Since the photoelectric absorption of AgBr varies rapidly with the energy of the incident radiation photographic film cannot be used for dose measurements with conventional roentgen rays with energies less than about 400 kv. (peak) and heavy filtration.

3. For 400 to 2,000 kv. (peak) roentgen rays, the situation is different. The production of photoelectric electrons is negligible in comparison with that of recoil electrons by the Compton process. The recoil electrons producing the film exposure are emitted mainly from the material adjacent to the film. Within this energy range (400 to 2,000 kv., peak), the emission of high energy secondary electrons and their interaction with the film emulsion are nearly independent of the radiation energy. Therefore, film dosimetry gives reliable and accurate results.

4. For dose measurements with high energy roentgen rays or gamma rays, the film should be surrounded by air-equivalent material of sufficient thickness. This will secure equilibrium between the primary roentgen rays and the secondary electrons, similar to that of "air-wall" ionization chambers. Then the film response can be calibrated in roentgen units. A systematic survey of film calibration has not yet been made for all kinds of roentgen-ray emulsions. Some information available from various authors[3,4,13] has been gathered in Figure 7. It shows the high energy roentgen-ray dose which produces a density of 1.0 for different types of photographic emulsions. Since not all of these data are obtained under the conditions outlined above, the accuracy for some of them might be poor. The data have been included to show that there is an emulsion type available for all dose levels.

5. If the relation between photographic density and radiation dose is linear for a certain developer-film combination, the film sensitivity can be determined by a single calibration exposure. For the industrial film, Eastman Kodak Type A, the response is proportional to the roentgen-ray dose up to a density of about $D=3$.

Therefore, this film is especially suitable for quantitative roentgen- or gamma-ray work if the film can be exposed to a dose of 1 to 10 roentgens.

6. Most roentgen films besides Type A film show an increase in film density which is not proportional to the radiation dose. In this case, a complete calibration curve is required for film dosimetry work.

Gerald J. Hine, Ph.D.
Radioactivity Center
Massachusetts Institute of Technology
Cambridge 39, Massachusetts

REFERENCES

1. Cormack, D. V., and Johns H. E. Electron energies and ion densities in water irradiated with 200 KeV, 1 MeV and 25 MeV radiation. *Brit. J. Radiol.*, 1952, *25*, 369–381.
2. Dudley, R. A. Measurement of beta radiation dosage with photographic emulsions. Massachusetts Inst. Technol. Ph.D. Thesis, 1951; and *Nucleonics*, 1954, *12*, No. 5, 24–31.
3. Ehrlich, Margarete, and Fitch, S. H. Photographic X- and gamma-ray dosimetry. *Nucleonics*, 1951, *9*, No. 3, 5–17.
4. Evans, R. D. Physical, biological, and administrative problems associated with transportation of radioactive substances. National Research Council of the National Academy of Sciences. Nuclear Science Series Preliminary Report No. 11, 1951.
5. Granke, R., Wright, K. A., Evans, W. W., Nelson, J. E., and Trump, J. G. Film method of tissue dose studies with 2.0 mev. roentgen rays. Am. J. Roentgenol., Rad. Therapy & Nuclear Med., August, 1954, *72*, 302–307.
6. Greening, J. R. Photographic action of x-rays. *Proc. Phys. Soc.*, Series B, 1951, *64*, 977–992.
7. Harrington, E. L., Johns, H. E., Wiles, A. P., and Garrett, C. Fundamental action of intensifying screens in gamma radiography. *Canad. J. Research*, 1948, *F-26*, 540–551.
8. Hine, G. J. Response of G-M counters and photographic emulsions to high-energy photons. *Nucleonics*, 1950, *7*, No. 4, 18–26.
9. Hine, G. J. Scattering of secondary electrons produced by γ-rays in materials of various atomic numbers. *Phys. Rev.*, 1951, *82*, 755–756.
10. Hine, G. J. Secondary electron emission and effective atomic numbers. *Nucleonics*, 1952, *10*, No. 1, 9–15.
11. Laughlin, J. S., and Davies, W. D. Procedure in dose distribution measurement of 25-Mev x-rays. *Science*, 1950, *111*, 514–516.
12. O'Connor, D. T. Film blackening method for measurement of relative x-ray intensities. *Industrial Radiography and Non-Destructive Testing*, 1947, *6*, No. 1, 40–43.
13. Wilsey, R. B. Use of photographic films for monitoring stray x-rays and gamma rays. *Radiology*, 1951, *56*, 229–241.

THE FILM METHOD OF TISSUE DOSE STUDIES WITH 2.0 MEV. ROENTGEN RAYS

By R. C. GRANKE, B.S., K. A. WRIGHT, A.B., B.S., W. W. EVANS, M.S., J. E. NELSON, M.D., *and* J. G. TRUMP, Sc.D.
Massachusetts Institute of Technology
CAMBRIDGE, MASSACHUSETTS

KNOWLEDGE of the dose delivered to both the treated region and the adjacent normal tissue is desirable in radiation therapy and necessary for the improvement of therapy procedures. Such radiation dose distributions are commonly obtained by calculating the contribution to the tissue dose of the several treatment beams at a sufficient number of points, or by making numerous ionization chamber measurements in a phantom which simulates the patient. For supervoltage roentgen radiation where interaction with matter is characterized by the Compton process, the photographic film technique employing a phantom offers an accurate and comparatively simple means of securing complete dose distribution studies in even the most complex situations.[8]

"Compton effect" is the dominant process by which roentgen- and gamma-ray energy in the range from about 1 to 20 million electron volts is absorbed in tissue or like materials. This absorption and scattering process refers to the interaction of incident roentgen-ray photons with free electrons. In these encounters the photons are scattered with a loss of energy which increases with the scattering angle, while the "recoil electrons" are accelerated by this energy in a generally forward direction. At 2 million volts the average range of these electrons in tissue is 3 to 4 millimeters. The Compton effect is unique in that it depends primarily on the number of electrons interposed in the path of the radiation and on the intrinsic energy of the photons themselves. Thus, the Compton effect increases with the density of the absorbing material and is little affected by the atomic number of its constituent atoms. Both the photoelectric absorption process, which is important for roentgen rays produced below 200 kilovolts, and the "pair production" process which begins to assume importance in tissue for energies above 20 million volts are dependent upon the density and a higher power of the atomic number of the absorbing atoms. Supervoltage radiation in the region in which the Compton effect predominates is thus particularly amenable to the photographic method of dose distribution study both because of the insensitivity of such radiation to the atomic number of phantom and film, and because the "recoil electrons" possess sufficient energy to traverse the small air gap and the film and the paper cassette immersed in the phantom.

PHANTOM CONSTRUCTION AND USE

Figure 1 shows a number of Masonite phantoms conforming to average anatomical dimensions in which photographic films may be inserted in the various transverse sections for dose distribution studies. The phantoms are built of ¼ inch layers of Masonite presdwood which has atomic constituents close to those of human tissue

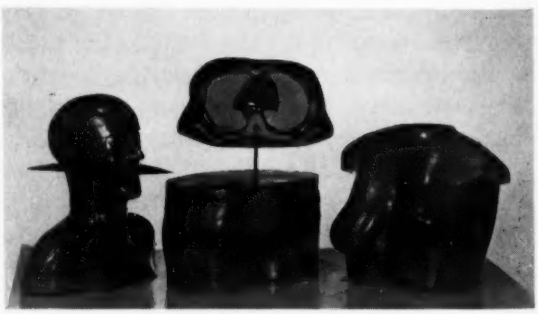


FIG. 1. Masonite phantoms of head, neck, and upper third, and of the upper and lower female trunk. Arrangement of paper-cassetted film for dose distribution study in oral section is shown.

and a density of 1.01. This commercially available material is made from clean exploded wood fiber and hydraulically pressed into sheet form without chemical binder and shows excellent homogeneity with considerable resistance to moisture absorption. The material was cut by band saw to dimensions given in Eycleshymer and Schoemaker's *A Cross-section Anatomy*, 1911, or to actual patient dimensions. The phantoms were assembled, cemented, shaped, and sealed with shellac by the F. W. Dixon Company of Cambridge, Massachusetts. The lung cavities in these phantoms have been filled with balsa wood to simulate lung tissue. In some phantoms the absorption equivalent of bone sections has been approximated by a mixture of calcium carbonate and sulphate. With well filtered 2.0 mev. roentgen rays this fidelity in the reproducing of the atomic constituents of bone and soft tissue in a minor point as the dose distribution is affected primarily by the density of the material.[2,6,7,9]

Measurements of depth dose along the axis of a roentgen-ray beam proceeding through a phantom have shown that the best correlation of photographic density and radiation dose is secured if the film is normal to the radiation beam. Nevertheless film dose distribution studies are most often made by delivering the supervoltage roentgen-ray beam through the anatomical region to be treated with the film sandwiched between sections lying in the plane or irradiation. In such cases the radiation proceeds parallel to the plane of the film and, since the secondary electrons move in a predominantly forward direction, some modification of the photographic exposure is caused by this orientation. Fortunately, as discussed below, the difference in film blackening obtained by normal and by parallel exposure of a film to the same amount of supervoltage radiation does not, in general, indicate a dose difference greater than 10 per cent. Even so, by using a film density relative dose curve taken with a film parallel to the roentgen-ray beam or by normalizing the film data to several ionization chamber measurements, any error due to beam orientation can be kept negligibly small.

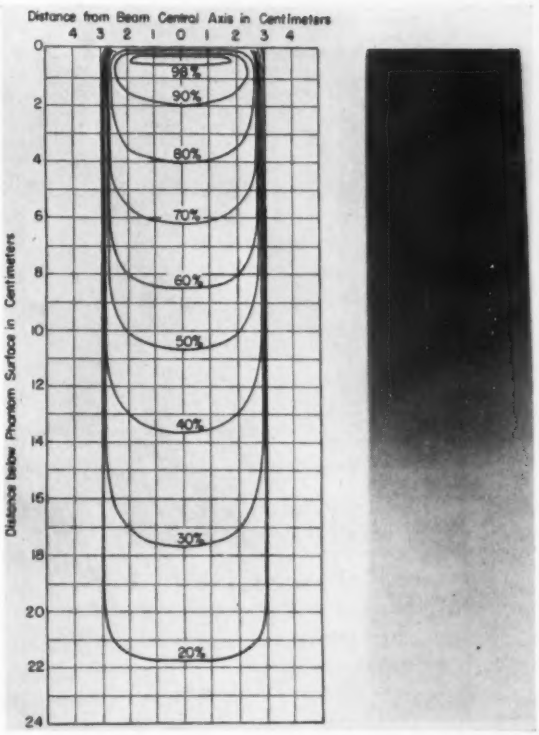


FIG. 2. Isodose curve for 2.0 mev. constant potential roentgen rays obtained from Type A industrial film immersed in Masonite phantom and exposed to a 5 by 5 cm. parallel beam. Other factors are: 100 cm. target-skin distance, 6.8 mm. equivalent Pb filter.

Figure 2 shows a film exposed in a Masonite block phantom to a 2 million volt roentgen-ray beam and the associated depth dose distribution derived by photometric analysis of the developed films. The 2 mev. roentgen rays were produced by a constant potential electrostatic accelerator of the Van de Graaff type and were filtered with the equivalent of 6.8 mm. of lead. The target-skin distance represented by this curve was 100 cm. and the field size was 5 by 5 cm. at the phantom surface. Figure 3 shows the isodose depth dose curves for a 10 by 10 cm. beam of 2.0 mev. roentgen rays obtained under otherwise similar conditions. The distribution of roentgen-ray intensity obtained by meas-

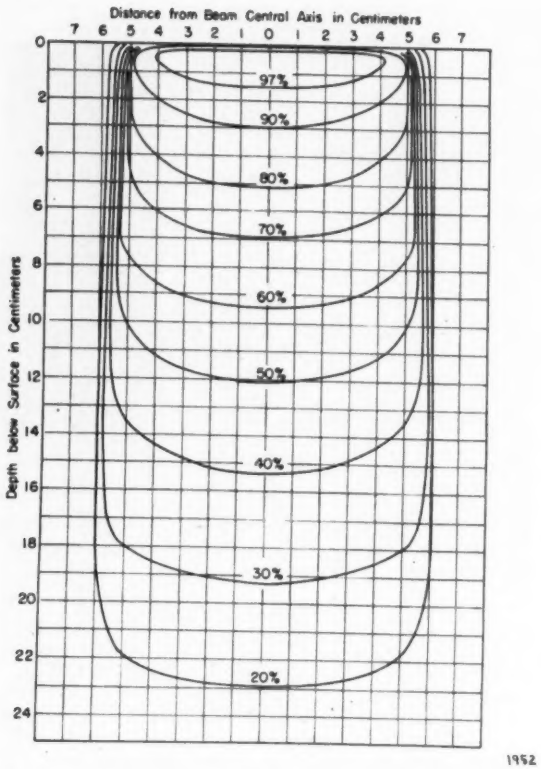


FIG. 3. Isodose curve for 2.0 mev. constant potential roentgen rays as determined by combined photometric and ion chamber analysis. Factors are 100 cm. target-skin distance, 6.8 mm. equivalent Pb filter, 10 by 10 cm. field at surface.

urements of the photographic film density was normalized to conform with ionization chamber measurements made at several points along the axis of the beam. This method of correcting photographic film measurements to conform with ionization chamber measurements is useful when high accuracy is desired, particularly when the film lies in the plane of the roentgen-ray beam. A flat circular "airwall" ionization chamber with 0.5 mm. electrode spacing and 2 cm. internal diameter was used with a suitable D.C. amplifier.

These single beam isodose curves for carefully calibrated 2.0 mev. constant potential radiation have been confirmed by repeated measurements and show somewhat higher depth dose values than our previously reported values.[3,8] The depth dose data are in close agreement with those taken independently by Howarth and his associates[4] at Sheffield using a similar 2.0 mev. electrostatic roentgen-ray source. Comparison with recently reported measurements by Johns and his associates[1,5] on cobalt 60 radiation shows almost exact coincidence in the distribution in depth of these two radiations.

PHOTOGRAPHIC TECHNIQUE

Although most types of film appear to be suitable, our experience has been obtained largely on Type A Kodak industrial film. These films are placed in a paper cassette constructed of moderate weight black paper having a density slightly less than 1.0 gm. per cc. When several film sheets are used in a single exposure, all the sheets are processed simultaneously in Kodak liquid developer and fixer so as to minimize errors due to developing and fixing. We have found it desirable to double the recommendations of the Eastman Kodak Company as to development times and to use fresh solutions. The temperature of the solution is maintained at approximately 68° F. and best results have been secured by agitating the film by hand with random motion for the first minute both of the developing and fixing periods. Although developed film densities have occasionally been found to change slowly with time, this difficulty has been traced to inadequate fixing.

Dose distribution studies are completed by drawing isodose lines along paths of constant photographic density on the exposed film. The density corresponding to maximum dose must be referred to a film calibration showing the relation of density to relative dose. From this calibration the lower densities corresponding to fractions of the maximum dose are readily determined. For each type of film and radiation it is thus necessary to obtain a photographic density-relative dose curve. This may be done by exposing a portion of a separate film to a defined beam of radiation, for gamma rays or 2 million volt roentgen rays the film being placed at least 4 mm. below the surface of the phantom to

secure equilibrium ionization conditions. A succession of films are given progressively increased doses in the relative amounts 2, 4, 8, 16, and 32. A typical density dose curve for Type A industrial film and 2 mev. radiation is shown in Figure 4. In order to avoid errors due to scattered radiation, it has been found necessary to use individual films from the same pack for each exposure rather than to place several exposures on a single film.

Most commercial photometers should prove suitable for film dose studies. We have found it convenient to mount the photometer head on the carriage of a simple coordinate table so that its position can be controlled independently by turning the X and Y axis screws. A stylus, moving parallel with the photometer head, is depressed by an electromagnet to record on a separate sheet the position of an isodose reading. Having first found the maximum photographic density of the developed film and marked it as 100 per cent dose on the film calibration curve, the reading corresponding to 97 per cent of this maximum dose is then taken as the level to be arbitrarily considered as the 100 per cent or maximum dose level. This avoids the difficulty that there is generally just one small area which reaches the pinnacle of dose. For lower dose levels, the densities corresponding to relative doses of 90 per cent or 80 per cent, etc., are read off the film calibration curve, and these densities then tracked around on the phantom film to produce the complete isodose lines.

In setting up the photometer an effort must be made to avoid errors due to scattered light from the film. We use a tungsten filament auto lamp with a stabilized A.C. power supply and define a 1.5 mm. diameter beam. This is directed through the film into the similarly restricted phototube opening. When the film has broad film illumination from underneath, considerable error can be caused by small variations in the film to photometer spacing.

In the supervoltage roentgen-ray region, the photographic response is brought about

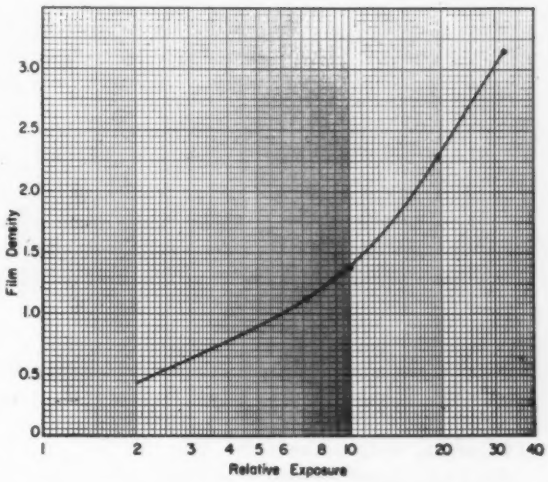


Fig. 4. Density-dose calibration obtained by exposure of Type A industrial film to 2.0 mev. radiation.

by excitation and ionization events within the silver bromide crystals produced almost entirely by electrons originating in the surrounding phantom material. The blackening, therefore, is representative of the ionization density in the phantom with the film constituting a minor disturbance and exhibiting some sensitivity to both the relative directions of the electrons and their energy. When film is exposed to ionization at progressively deeper distances within the phantom, it might be expected that the density produced on the deeper films would be affected by the diminishing quality of the ionization. This gradual reduction of roentgen-ray quality within the phantom results from the increasing contribution of both side and back scattered radiation and would increase somewhat with field size and total phantom thickness. Since film sensitivity increases at lower energies, this diminished quality with depth would have the effect of increasing the photographic response to a given dose of radiation measured in roentgens. Comparison of film density with ionization chamber measurements along the axis of the beam shows that the photographic depth doses with parallel film orientation run progressively higher than ionization chamber values. Figure 5 compares the central axis depth dose for

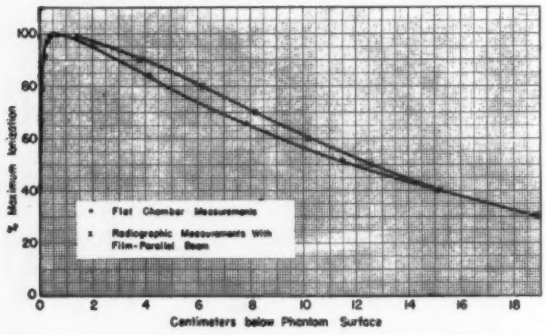


FIG. 5. Comparison of central axis depth dose obtained roentgenographically with ionization chamber measurements for 2.0 mev. constant potential roentgen rays, 6.8 mm. Pb filter, 10 by 10 cm. field, at 100 cm. target-skin distance. The film was parallel to the roentgen-ray beam axis.

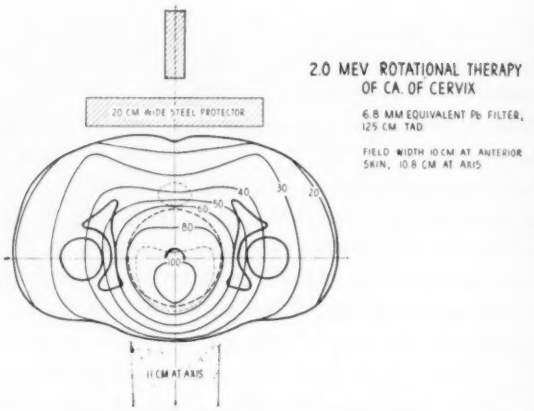

2.0 MEV ROTATIONAL THERAPY
OF CA. OF CERVIX
6.8 MM EQUIVALENT Pb FILTER,
125 CM. TAD
FIELD WIDTH 10 CM AT ANTERIOR
SKIN, 10.8 CM AT AXIS
20 CM WIDE STEEL PROTECTOR
11 CM AT AXIS

FIG. 6. Dose distribution obtained photometrically by the rotational irradiation of the pelvic cavity with 2.0 mev. roentgen-ray beam of 11 cm. diameter at axis and with 20 cm. wide lead absorber directly posterior to the phantom.

2.0 mev. roentgen rays obtained roentgenographically with a film-parallel beam with the corresponding depth dose distribution obtained with a thin flat ionization chamber.

The full advantage of the photographic film technique for dose distribution studies is realized when the program calls for a fairly large number of investigations of a complex nature. Figure 6 shows resultant film dose distribution obtained in treating tumors of the pelvic cavity by rotation with 2 million volt radiation. The advantage of having quantitative information on the doses sustained throughout the entire section is very great, particularly when the purpose of the study is to appraise the merits of various portal techniques. As experience is acquired, the exposed film gives qualitative information on the dose distribution even in advance of photometric analysis. It moreover serves as a convenient permanent record of the study.

DIFFICULTIES AT LOWER ROENTGEN-RAY VOLTAGES

Sufficient difficulties have been experienced in attempting to use the photographic techniques at voltages of 200 kv. and below to indicate that its usefulness for dose distribution studies at these voltages may be quite limited. Much dependence has been found upon the existence of air gaps between the film and the phantom material, and unless great smoothness of contact and of pressure has been secured, the exposed film exhibits a mottled effect. At these voltages a marked dependence is also observed on the thickness of the cassette paper, on inhomogenieties in the atomic number of the phantom constituents, and on the direction of the roentgen-ray beam. These difficulties are due to the relatively low energy and short range of the electrons, together with the increased importance of photoelectric absorption and the associated nonlinear film response. When studies were attempted of the distribution of 200 kv. roentgen rays in tissue containing bone, the photographic density within the bone was found to be less than that in the tissue, although the energy absorbed per gram within bone was known to be higher. The physical explanation for this phenomenon in inhomogeneous media probably includes the fact that while the energy absorbed within the bone material is actually greater, the ability of low energy electrons to escape from the bone material into the film is lessened, with the result that the film receives an erroneously low record of the local electron density.

SUMMARY

1. The photographic film method of studying radiation dose distribution possesses advantages of simplicity and wealth of quantitative information when used with roentgen rays in the 1 to 20 mev. range in which the Compton process of interaction with tissue predominates.

2. As compared with ionization chamber measurements, the photographic film, when parallel to the incident beam, will indicate somewhat higher ionization density at considerably greater depths in tissue because of the film dependence on roentgen-ray quality and other factors.

3. Normal orientation of the film with respect to the roentgen-ray beam produces the most accurate results. The parallel orientation is permissible and usually more convenient. For the latter, correlation with ionization chamber measurements will produce results which are well within the limits of tolerance for applications to therapy.

4. Radiation film technique is less suitable to lower voltages where photoelectric absorption is important because of its strong dependence on atomic number and because of the short range of the secondary electrons.

J. G. Trump, Sc.D.
High Voltage Research Laboratory
Massachusetts Institute of Technology
Cambridge 39, Massachusetts

The work reported here was done in part with the aid of grants from the American Cancer Society. The other authors desire to acknowledge the stimulating influence of Dr. Joseph Eugene Nelson who was a valued member of the High Voltage Research Laboratory at the time of his accidental death on May 22, 1949, and whose enthusiasm and high professional competence contributed greatly to the development of phantoms of anatomical shape.

REFERENCES

1. Dixon, W. R., Garrett, C., and Morrison, A. Radiation measurements with Eldorado cobalt^{60} teletherapy unit. *Brit. J. Radiol.*, 1952, *25*, 314–318.
2. Greening, J. R. Photographic action of x-rays. *Proc. Phys. Soc.*, Series B, 1951, *64*, 977–992.
3. Hare, H. F., *et al.* Physical and clinical aspects of supervoltage rotational therapy. *Radiology*, 1951, *57*, 157–168.
3a. Hine, G. J. Range of usefulness of photographic film in roentgen dosimetry. Am. J. Roentgenol., Rad. Therapy & Nuclear Med., August, 1954, *72*, 293–301.
4. Howarth, J. L., Jones, J. C., and Miller, H. Physical measurements on 2 MeV x-ray generator. *Brit. J. Radiol.*, 1951, *24*, 665–675.
5. Johns, H. E., Epp, E. R., Cormack, D. V., and Fedoruk, S. O. Depth dose data and diaphragm design for Saskatchewan 1000 curie cobalt unit. *Brit. J. Radiol.*, 1952, *25*, 302–308.
6. Laughlin, J. S., and Davies, W. D. Procedure in dose distribution measurement of 25-Mev x-rays. *Science*, 1950, *111*, 514–516.
7. Spiers, F. W. Materials for depth dose measurement. *Brit. J. Radiol.*, 1943, *16*, 90–97.
8. Trump, J. G., Wright, K. A., Evans, W. W., Hare, H. F., and Lippincott, S. W., Jr. Two million volt roentgen therapy using rotation. Am. J. Roentgenol. & Rad. Therapy, 1951, *66*, 613–623.
9. Wilsey, R. B. Use of photographic films for monitoring stray x-rays and gamma rays. *Radiology*, 1951, *56*, 229–241.

THE AMERICAN JOURNAL OF ROENTGENOLOGY, RADIUM THERAPY AND NUCLEAR MEDICINE

Editor: LAWRENCE REYNOLDS, M.D. *Assistant Editor:* RUTH BIGELOW, B.S.

Associate Editors: HARRY HAUSER, M.D., TRAIAN LEUCUTIA, M.D., RUSSELL H. MORGAN, M.D., EDWARD B. D. NEUHAUSER, M.D., WENDELL G. SCOTT, M.D.

Consulting Editorial Board: See front cover.

Published by: CHARLES C THOMAS, PUBLISHER, 301–327 East Lawrence Avenue, Springfield, Illinois.

Issued monthly. Annual subscription: United States, Mexico, Cuba, Central and South America, $15.00; Canada, $16.00; other countries, $17.00. Current single numbers, $1.50. Advertising rates submitted on application. Editorial office, 110 Professional Building, Detroit 1, Michigan. Office of publication, 301–327 East Lawrence Avenue, Springfield, Illinois. Information of interest to authors and readers will be found on page v.

Officers and Standing Committees

AMERICAN ROENTGEN RAY SOCIETY

President: Harry M. Weber, Rochester, Minn.; *President-Elect*: Joshua C. Dickinson, Tampa, Fla.; *1st Vice-President*: Wilbur Bailey, Los Angeles, Calif.; *2nd Vice-President*: David G. Pugh, Rochester, Minn.; *Secretary*: Barton R. Young, Germantown Hospital, Philadelphia 44, Pa.; *Treasurer*: Wendell G. Scott, 35 North Central Ave., Clayton 5, Mo.

Executive Council: H. M. Weber, J. C. Dickinson, Wilbur Bailey, D. G. Pugh, B. R. Young, W. G. Scott, Lawrence Reynolds, E. L. Jenkinson, R. H. Morgan, E. B. D. Neuhauser, C. L. Martin, H. D. Kerr, H. O. Peterson, W. E. Chamberlain, Paul C. Hodges, Chairman, 950 East 59th St., Chicago 37, Illinois.

Program Committee: B. R. Young, Philadelphia, Pa., R. H. Morgan, Baltimore, Md., Lawrence Reynolds, Detroit, Mich., E. B. D. Neuhauser, Boston, Mass., P. C. Hodges, Chicago, Ill., Joshua C. Dickinson, Chairman, 603 Citizens Bldg., Tampa 2, Fla.,

Publication Committee: R. J. Reeves, Durham. N. C., M. J. Geyman, Santa Barbara, Calif., R. H. Morgan, Chairman, Baltimore, Md.

Finance Committee: J. L. Olpp, Englewood, N. J., R. K. Arbuckle, Oakland, Calif., E. L. Jenkinson, Chairman, Chicago, Ill.

Committee on Scientific Exhibits: C. A. Good, Rochester, Minn., W. A. Evans, Jr., Detroit, Mich., E. B. D. Neuhauser, Chairman, Boston, Mass.

Representatives on American Board of Radiology: B. R. Kirklin, Rochester, Minn., H. Dabney Kerr, Iowa City, Iowa, U. V. Portmann, Tucson, Ariz.

Representative on National Research Council: A. O. Hampton, Washington, D. C.

Editor: Lawrence Reynolds, 100 Professional Building, Detroit 1, Mich.

Assistant Editor: Ruth Bigelow, 110 Professional Building, Detroit 1, Mich.

Fifty-fifth Annual Meeting: Shoreham Hotel, Washington, D. C., September 21–24, 1954.

AMERICAN RADIUM SOCIETY

President: John E. Wirth, Pasadena, Calif.; *President-Elect:* Grant H. Beckstrand, Long Beach, Calif.; *1st Vice-President:* Norman A. McCormick, Windsor, Ont.; *2nd Vice-President:* W. Edward Chamberlain, Philadelphia, Pa.; *Secretary:* Robert E. Fricke, Mayo Clinic, Rochester, Minn.; *Treasurer:* Douglas J. Roberts, 85 Jefferson St., Hartford 6, Conn.

Executive Committee: Howard B. Hunt, Chairman, Omaha, Nebr., Hugh F. Hare, Los Angeles, Calif., Edith H. Quimby, New York, N. Y.

Program Committee: John E. Wirth, Chairman, Pasadena, Calif., James F. Nolan, Los Angeles, Calif., Jesshill Love, Louisville, Ky., Theodore R. Miller, New York, N. Y., Grant H. Beckstrand (ex officio), Long Beach, Calif.

Publication Committee: Harry Hauser, Chairman, Cleveland, Ohio, Martin Van Herik, Rochester, Minn., Jacob R. Fried, New York, N. Y.

Public Relations Committee: Robert L. Brown, Chairman, Emory University, Ga., John A. Wall, Houston, Texas, Calvin T. Klopp, Bethesda, Md.

Janeway Lecture Committee: Douglas Quick, Chairman, New York, N. Y., Gioacchino Failla, New York, N. Y., H. Dabney Kerr, Iowa City, Iowa.

Representatives on the American Board of Radiology: Douglas Quick, New York, N. Y., B. P. Widmann, Philadelphia, Pa., Frederick W. O'Brien, Boston, Mass.

Committee on Arrangements: Ralph M. Caulk, Chairman, Washington, D. C. Murray M. Copeland, Washington, D. C. John V. Blady, Philadelphia, Pa., Robert L. Brown, Emory University, Ga., John E. Wirth (ex officio), Pasadena, Calif.

Representatives on National Committee on Radiation Protection: Edith H. Quimby, New York, N. Y., Theodore P. Eberhard, Philadelphia, Pa.

Thirty-seventh Annual Meeting: Shoreham Hotel, Washington, D. C., April 21–23, 1955.

EDITORIALS

ELECTRON BEAM THERAPY

DURING the past decade considerable interest has been manifested in the therapeutic possibility of irradiation with electron beams extracted from powerful apparatus ordinarily used for the production of roentgen rays. The energy range of such electron beams has continuously been expanded and the clinical application gradually widened.

Trump and Hare and their co-workers[1] in April, 1953, published their experience with a 2.5 mev. electron beam which they have extracted from a compressed gas-insulated electrostatic accelerator of the Van de Graaff type at the Massachusetts Institute of Technology. This apparatus was built for research with both electrons and roentgen rays and was prepared for electron beam therapy in August, 1951. The upper limit of its energy range is 4 mev.

Electron beams with energies up to 6 mev. have been used for medical purposes at the Second Physical Institute of the University of Göttingen and the Medical Clinic of the University of Erlangen since 1946. These beams are extracted from a 6 mev. betatron[2] which likewise is built for therapy with both roentgen rays and electrons. Very recently, a 15 mev. betatron has been constructed which, through the ingenious device of the late Dr. Gund and of Berger,[3] permits instantaneous interchange of the two types of radiations. Furthermore, this new model has been made so light that it is possible to mount it on a vertical supportive stand permitting great flexibility and easy positioning in clinical use.

The fastest electrons employed for medical purpose at the present time are those extracted from the 22 mev. betatron at the University of Illinois College of Medicine in Chicago. Prof. D. W. Kerst, at the time of his development of the betatron in 1940, foresaw that this apparatus might with time be utilized for the production of roentgen rays as well as of high energy electrons —and in March, 1951, Harvey, Haas and Laughlin[4] for the first time made use of this latter possibility. The electron beam of the Chicago betatron may be extracted at any desired energy level between 2 and 22 mev., although instantaneous or even rapid interchange between the two types of radiations is not possible in this early model.

The three principal factors for the therapeutic evaluation of a new kind of radiation are the physical properties of the radiation beam, the spatial distribution of the dose within the tissue and the biologic equivalence of the dose absorbed.

As regards the first factor, it may be said that the electron beams emerging from the different megavoltage accelerators vary in configuration, intensity and beam size, depending on the several methods used for extraction and on the physical arrangements provided for their collimation and homogenization. In the main, they are precisely defined and, in contradistinction to the electrons of the natural or radioactive sources which are emitted in all directions with varying energies, they are propagated in the forward direction with a uniform en-

[1] Trump, J. G., Wright, K. A., Evans, W. W., Anson, J. H., Hare, H. F., Fromer, J. L., Jacque, G., and Horne, K. W. High energy electrons for treatment of extensive superficial malignant lesions. AM. J. ROENTGENOL., RAD. THERAPY & NUCLEAR MED., April, 1953, *69*, 623–629.

[2] Gund, K., and Paul, W. Experiments with a 6-mev. betatron. *Nucleonics*, 1950, *7*, No. 7, 36–45.

[3] Gund, K., and Berger H. Die 15-MeV-Elektronenschleuder für medizinische Anwendung der Siemens-Reiniger-Werke. *Strahlentherapie*, 1953, *92*, 489–505.

[4] Harvey, R. A., Haas, L. L., and Laughlin, J. S. Effects of x-ray and electron beam from the betatron on head and neck cancer. Proceedings of Second National Cancer Conference, Cincinnati, 1953.

ergy proportional to the applied acceleration. According to Laughlin, Ovadia, Beattie, Henderson, Harvey and Haas,[5] however, since the electrons originate from a source of finite dimensions rather than from a point-source, a full homogenization of the beam density is not completely attained. This fact is responsible, as will be shown later, for the less sharply defined isodose contours in tissues as compared to those produced by the absorption of roentgen rays of equivalent energies. An unexpected physical advantage of the electron beams over similar roentgen-ray beams is that they can be angulated, permitting irradiation sidewise. Thus, Markus and Paul,[6] by using thin lead foils as scatterers, were able to construct a cone which can easily be inserted into a body cavity for treatment of lesions located on the lateral walls of the cavity.

The second factor concerns the spatial distribution of the dose in tissues. In the case of electron beams, this is determined by the number of impinging electrons and their range which, in turn, is a function of the accelerating voltage. Trump and Hare and their co-workers[1] found that the maximum range, or distance traveled in being brought to rest, in tissue of such electrons is approximately 10 mm. for each 2 mev. acceleration. This fact was also confirmed by Kepp[7] and by Laughlin and his co-workers.[5] With increasing voltage the spatial distribution of the ionization along the electron path changes. As the high speed electron particles traverse the subsequent tissue layers, they dissipate energy through collisions with atoms producing primary and secondary ionizations or excitation of the struck atoms. In so doing, they gradually slow down with the result that the number of ions per micron path, or the so-called specific ion-density or differential ionization, increases. Toward the end of the track still further increase of the specific ion-density is produced by the Bremsstrahlung. This increase of the specific ion-density along the entire length of the track of a high speed electron, together with the significant number of ions formed by tertiary or additional electrons, according to Kepp[8] makes it desirable to express the density of the total ionization in terms of the mean ionization density.

After taking into account these considerations as well as the already mentioned incomplete homogeneity of the external electron beam as a whole, Markus and Paul[9] arrived at the conclusion that an electron beam is best characterized by specifying the actual distribution of the dose density in the irradiated medium. This procedure may be replaced by stating the following factors: (1) energy of the electrons; (2) dose density at a predetermined point of the irradiated medium, preferably the specific surface dose in erg/g or the specific dose in air above the surface in erg/g or r; (3) specific surface dose rate in erg/g-sec. or specific dose rate in air above the surface in r/sec., respectively r/min.; (4) divergence of the beam, determined by the half-value width of the beam at two different distances from the donut window or by the distance of the object from the donut window or from the scattering foils used to increase the size of the radiation field; (5) size of the irradiated field and (6) type of tissue irradiated.

Laughlin and his co-workers,[5] in a splendidly documented article, dealt in extenso with the problems of physical dosimetry involved in electron beam therapy. They extended their measurements to energy ranges of 2 to 22 mev. and thus were able to obtain comparative data. In general, they found that the depth dose isodose contours at lower energies and with smaller fields were more precisely defined than at

[5] Laughlin, J. S., Ovadia, J., Beattie, J. W., Henderson, W. J., Harvey, R. A., and Haas, L. L. Some physical aspects of electron beam therapy. *Radiology*, Feb., 1953, *60*, 165–185.

[6] Markus, B., and Paul, W. Ein Körperhöhlenrohr für Elektronenbestrahlungen mit dem Betatron. *Strahlentherapie*, 1953, *92*, 621–630.

[7] Kepp, R. K. Die Verwendung schneller Elektronen in der Strahlentherapie. *Radiol. Austriaca*, 1953, *6*, 213–233.

[8] Kepp, R. K. Zur Frage der strahlentherapeutischen Anwendung schneller Elektronen. *Deutsche med. Wchnschr.*, 1951, 26, 639–644 (see abstract this JOURNAL, 1952, *67*, 694–695).

[9] Markus, B., and Paul, W. Über Dosismessung und Dosisverteilungen in elektronenbestrahlten Körpern. *Strahlentherapie*, 1953, *92*, 599–611.

higher energies and with larger fields. Likewise, the drop of intensity near the end of penetration was steeper at the lower energies than at the higher energies. The depth of the rather homogeneous maximum dose distribution extended to about one-third of the finite range and the depth of the useful biological effect to about two-thirds of this range. In using beams of 6 to 12 cm. in diameter, the relative depth dose for the smaller beam sizes decreased at lesser depths than for the larger beam sizes.

Laughlin and his co-workers[9] give a convenient empirical formula for the calculation of the central depth dose and they describe a practical method for the calculation of the integral or volume dose to any depth up to the 10 per cent dose level for uniform electron beams below 20 mev. energies. They also call attention to the fact that in water polarization effects due to the density of the medium have been shown to reduce the stopping power for fast electrons and that, therefore, correction for "polarization" is necessary in calculating the energy loss in tissue.

The third, and perhaps the most important factor from the point of view of clinical evaluation, is the biologic equivalence of the absorbed physical dose. As interpreted at the present time, this factor depends mainly on the varying mean ionization density produced by the different types of radiations. As compared to roentgen rays the fast electrons have a considerably smaller median ionization density and therefore are less effective for equal doses in irradiating human tissues.

Dittrich and Schubert[10] studied the effect of fast electrons on a great variety of biologic objects. These authors found that the action of fast electrons, like that of all ionizing radiations, is partly direct and partly indirect. The relative biologic effect, when compared with 200 kv. roentgen rays, was found to vary within wide limits. In the majority of instances, however, the fast electrons have proved to be less efficient than the 200 kv. roentgen rays, thus confirming the above stated theoretical considerations. This was particularly true of reactions associated with the liberation of large groups of free H-atoms and OH-radicals, a fact which would seem to indicate that there is a qualitative difference between the biologic action of the fast electrons and that of the roentgen rays of medium energy.

On the other hand, it appears that there is also a quantitative difference and that irradiation with fast electrons of low mean ionization density produces a greater biologic effect than roentgen rays of medium energy if it is applied in large doses. Gärtner and Peters,[11] to prove this, performed a series of experiments in tissue cultures by studying the effect of delayed mitosis of fibroblasts of the heart of the chicken. They found that up to 3,000 r there was a statistically lesser effect of the fast electrons as compared to similar doses of roentgen rays, then the difference diminished and at 4,000 r it disappeared. Accordingly, larger doses of fast electrons were relatively more efficient than smaller doses. The index of dose equivalence, which was 0.69 at 250 r with 10.8 mev. and 1,000 r/min., rose with increasing dose and became 1 at 4,000 r.

The influence of the time factor on the biologic dose equivalence in treating with various electron beams of high energies must be separated into two parts. First, there is the influence of the dose rate which is expressed in r/min. It was found generally, that with fast electrons as with roentgen rays, the biologic effect is greater when the dose is administered at a lower rate, that is over a longer time, than at a higher rate. Secondly, with the exception of the Van de Graaff electrostatic accelerator, all other apparatus used at the present time for production of high energy electron beams do not emit the electrons continuously but in

[10] Dittrich, W., and Schubert, G. Der Wirkungsmechanismus schneller Elektronen in biologischer Materie. *Strahlentherapie*, 1953, *92*, 532–554.

[11] Gärtner, H., and Peters, K. Einfluss der Dosis und Dosisleistung von Röntgenstrahlen und schnellen Elektronen auf die Mitosenhäufigkeit in Gewebekulturen. *Strahlentherapie*, 1953, *92*, 555–562.

"bursts" of very short duration. For example, in the 6 mev. betatron of the Siemens-Reiniger-Werke the electron beam consists of 500 main pulses per second and in the 15 mev. betatron of 50 main pulses per second.[12] This so-called ultrafractionation of the irradiation seems to present no serious difficulty from the point of view of the physical aspect of dosimetry but, according to Kepp,[12] must be taken into consideration in evaluating the biologic dose equivalence. Still another problem to be considered in relation to the study of the time factor influence is whether the irradiation is given singly or in multiple fractions spaced at regular intervals over a definite period of time.

The above enumerated features of the high energy electron beams would seem to indicate that treatment with this new form of radiation may be of definite value in certain lesions, mostly malignant neoplasms, situated on or near the surface of the body. Practical clinical experience, however, is still limited. The largest group of cases was apparently treated at the University of Göttingen. Bode, Hampel and Markus[13] recently published the results obtained at that institution in a series of cases irradiated with fast electrons of the 6 mev. betatron between March, 1949, and October, 1952. This series includes 149 cases of carcinoma of the skin and lip, 4 cases of carcinomatous metastases to superficial lymph nodes, 10 cases of precancerous lesions and 19 cases of melanomas. The irradiation was carried out with single doses amounting on the surface to 1,500 r in precancerous lesions, 2,000 r in carcinoma of the skin and lip, and in the carcinomatous metastases to the superficial lymph nodes and to 3,000 r in melanomas. The energy used varied from 2 mev. to 3.8 mev. and the specific dose rate was 500 or 1,000 r/min.

In reviewing the experience gained in treating this series, Bode, Hampel and Markus[13] state that, although the final results have been quite satisfactory, they could have been obtained in most instances equally well with the conventional methods of roentgen irradiation. They feel that further extensive investigations are necessary before a definite answer can be given to the question of whether or not the biologic effect of the fast electrons differs qualitatively or quantitatively from that of the roentgen rays, as demonstrated experimentally. The greatest advantage of electron beam therapy, in their estimation, is the unusually favorable spatial distribution of the dose throughout the irradiated tumor. The skin changes following the irradiation and the late sequelae for the rather short period observed seem to be the same as noted in roentgen therapy.

Electron beams of energies greater than 6 mev. have been used for the first time in the treatment of malignant neoplasms at the University of Illinois College of Medicine in Chicago, as already stated, in March, 1951. In this issue of the JOURNAL, Haas, Harvey, Laughlin, Beattie and Henderson[14] give an excellent account of their experience based on study of a group of representative cases. Like Bode, Hampel and Markus,[13] they, too, found the favorable spatial distribution of the dose to be the greatest asset since, with the possibility of adjusting the voltage between 2 and 22 mev., any lesion from the skin surface down to a depth of 8 cm. below the surface can be exposed rather uniformly. Immediately beyond the lesion there is a rapid fall of the dose, so that the surrounding normal structures are adequately protected. Haas, Harvey, Laughlin, Beattie and Henderson[14] noted that the index of biologic equivalence of high energy electrons on human skin, mucosa and tumor as compared to 400 kv. roentgen radiation is approximately 0.70. This means that, for example, a tumor dose of 8,600 r of fast electrons, which in some of their cases was delivered with 17.3 mev.

[12] Kepp, R. K. Zusammenhänge zwischen Ionisationsdichte und Zeitfaktorwirkung. *Strahlentherapie*, 1953, *92*, 590–598.

[13] Bode, H.-G., Hampel, D., and Markus, B. Weitere Erfahrungen in der Geschwulstbehandlung mit schnellen Elektronen. *Strahlentherapie*, 1953, *92*, 563–575.

[14] Haas, L. L., Harvey, R. A., Laughlin, J. S., Beattie, J. W., and Henderson, W. J. Medical aspects of high energy electron beams. AM. J. ROENTGENOL., RAD. THERAPY & NUCLEAR MED., August, 1954, *72*, 250–259.

This issue of the JOURNAL also contains a number of abstracts on electron beam therapy.

in multiple fractions over a period of thirty-three days, is equivalent to a dose of about 6,000 r delivered with 400 kv. roentgen rays in a similar fashion.

Obviously, electron beam therapy with high energies is only at the threshold of its useful clinical applicability. There are many complex problems of physical dosimetry, technical methodology and biologic evaluation which require further exhaustive studies before the true clinical value of this new kind of beam radiation can be fully appreciated. It is very fortunate that the constructional development of apparatus used for the production of electron beams has progressed to the stage whereby such studies are made possible.

T. Leucutia, M.D.

Harper Hospital
Detroit 1, Michigan

WALTER COIT HILL
1876–1953

ON SEPTEMBER 6, 1953, the American Roentgen Ray Society lost one of its oldest and most enthusiastic members, Dr. Walter Coit Hill of Cleveland, Ohio. Dr. Hill was elected to membership in the Society in 1906 and remained on the roster of active members until his death.

At the time of his election he was the radiologist at Lakeside Hospital of the School of Medicine of Western Reserve University. In 1907 he joined with the late Dr. George F. Thomas in the formation of one of the earliest partnerships of radiologists in this country. This partnership of

Doctors Hill and Thomas, now comprised of seven members, is still active in Cleveland radiological circles.

Dr. Hill always enjoyed reminiscing about the early days of the American Roentgen Ray Society. Through the Society he and Dr. Thomas became close friends of Dr. Preston M. Hickey of Detroit and Harry W. Dachtler of Toledo. These four met frequently throughout the years before the First World War cementing their friendship and exchanging valuable technical information.

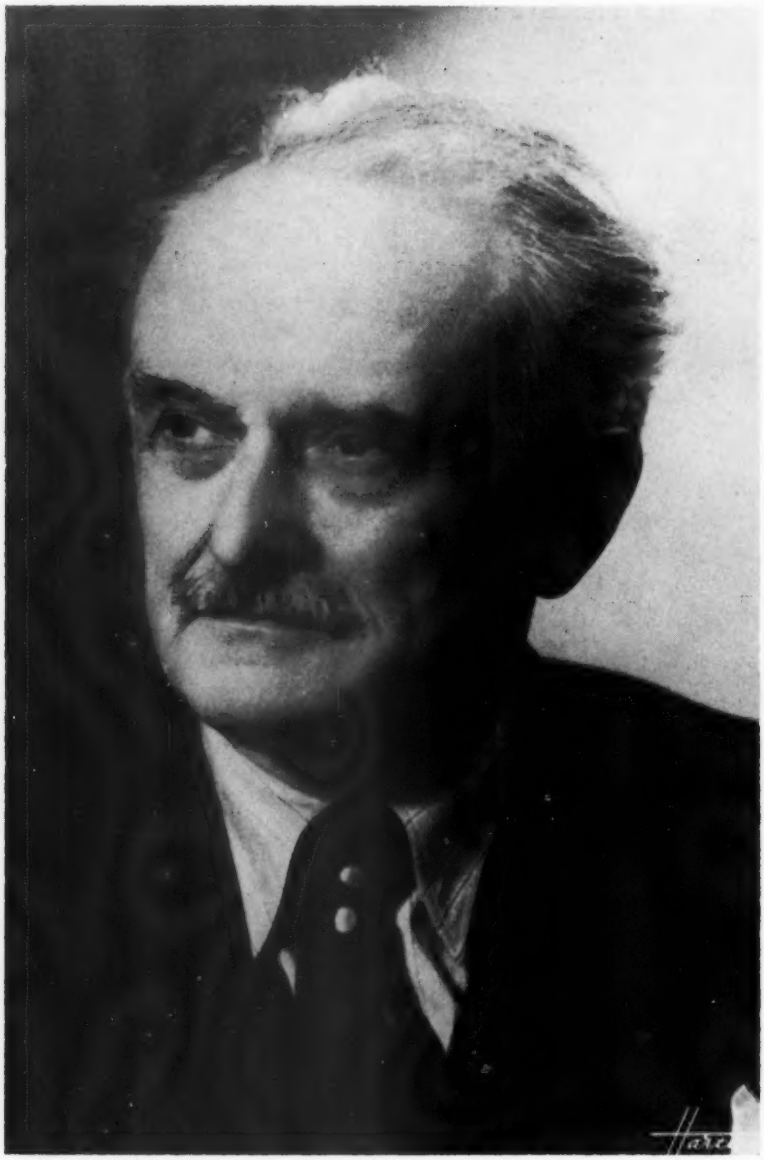
Dr. Hill was commissioned a First Lieutenant at the outbreak of World War I and was in charge of the X-ray Department of Base Hospital No. 4, the first American Unit to arrive overseas. He was later transferred to England where he was Chief X-ray Consultant for the American installations on the British Isles and where he attained the rank of Major.

Up to the time of his retirement Dr. Hill was an enthusiastic golfer and frequently competed in the golf tournaments held at the annual meetings of the American Roentgen Ray Society.

Although retired from the active responsibilities of practice since 1939, Dr. Hill retained an active interest in radiology and visited his offices almost daily. All who knew Dr. Hill will remember his enthusiasm and his joy of living. Those who knew him well will also remember his devotion to work, his unselfishness and humbleness that came from a life time of wise observation and the realization that art is indeed long and judgment difficult.

Dr. Hill's only survivor is his wife, Virginia.

George L. Sackett, M. D.



JOSEPH BELOT
1876–1953

OVER a year ago France lost one of her most distinguished radiologic pioneers in Joseph Belot who paid with his life for too long and too close association with the roentgen ray. Many years of slow and unremitting suffering from a serious blood disorder attributable to his professional work brought an end to his life on May 24, 1953.

Belot began his professional work as an extern of the Hôpitals de Paris, then assistant to the late Dr. Antoine Béclère at the Hôpital Saint-Antoine. In 1903 he began to give special attention to radiotherapy and

this was the subject of his inaugural thesis in 1904. This thesis was later expanded and published as the "Traité de Radiothérapie." Because of his broad training as an engineer, mechanician and physician, his excellent talents were utilized during the First World War as Chief of the Radiologic Service of the 13th Region, with headquarters at Vichy, where he directed the radiotherapeutic management of reconstruction and recuperation and readjustment of the war mutilated. In 1916 he was was made Chevalier of the Legion of Honor. In 1919 after the close of the war, he resumed direction of the Radiologic Department in the Dermatologic Service of Prof. Brocq; later, he was named chief of the service of electroradiology of the Hôpital Saint Louis, where by uniting the therapeutic and diagnostic services under one service he created a central service of electroradiology. Later he supervised the creation of the service of radiology and radiotherapy of the Cancer Institute at Villejuif, of which service he was the Medical Director. In 1939 the Minister of War appointed him Chief of the Radiologic Service of the Army. He gave personal attention to the supervision, manufacture and maintenance of the equipment. After the armistice he resumed his work at Villejuif which he continued until 1945. In commemoration of his service, a testimonial plaque was placed over the entrance to the service which he founded and directed.

Following his retirement from this post, he continued his consultations and scientific work and the editorial tasks with the *Journal de radiologie et d'électrologie* of which he was one of the founders and to which he had given much attention all of his life. In 1953 his health obliged him to retire completely and the end came to him on May 24, 1953, at his country home at Thiel-sur-Acolin.

Dr. Belot was a member of the Commission of Radiologic Teaching at the Faculty of Medicine, and he always exerted an important influence on the development of radiology not only in France but abroad. In 1930 he visited the universities in Quebec and Montreal. He was Vice President of the Third International Congress of Radiology in Paris, 1931; head of the French delegation to the International Congresses of Radiology in Chicago and in London, and a member of the delegation to the Congresses held in Stockholm and Zürich.

In addition to his "Traité de Radiothérapie" he was the author of innumerable articles on subjects relating to his specialty. His special talents enabled him to devise many radiologic instruments and protective devices. He early insisted upon the employment of protective material around the roentgen tubes. Belot occupied an important place in the establishment of radiology, especially therapeutic radiology, as a purely medical specialty to be practiced only by doctors of medicine. Dr. Belot's many friends in this country join in paying homage to this distinguished radiologist.

James T. Case, M.D.

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

MEETINGS OF ROENTGEN SOCIETIES*

United States of America

American Roentgen Ray Society
Secretary, Dr. Barton R. Young, Germantown Hospital, Philadelphia 44, Pa. Annual meeting: Shoreham Hotel, Washington, D.C., Sept. 21–24, 1954.

American Radium Society
Secretary, Dr. R. E. Fricke, Mayo Clinic, Rochester, Minn. Annual meeting: Shoreham Hotel, Washington, D. C., April 21–23, 1955.

Radiological Society of North America
Secretary, Dr. D. S. Childs, 713 E. Genesee St., Syracuse 2, N. Y. Annual meeting: Biltmore Hotel, Los Angeles, Calif., Dec. 5–10, 1954.

American College of Radiology
Executive Secretary, William C. Stronach, 20 N. Wacker Drive, Chicago 6, Illinois.

Section on Radiology, American Medical Association
Secretary, Dr. T. Leucutia, Harper Hospital, Detroit 1, Mich.

Fifth Inter-American Congress of Radiology
General Secretary, Dr. Eugene P. Pendergrass, 3400 Spruce St., Philadelphia 4, Pa. Meets at Shoreham Hotel, Washington, D. C., April 24–29, 1955.

Alabama Radiological Society
Secretary, Dr. J. A. Meadows, Jr., Medical Arts Bldg., Birmingham 5, Ala. Meets time and place Alabama State Medical Association.

Arizona Radiological Society
Secretary, Dr. R. Lee Foster, 507 Professional Bldg., Phoenix, Ariz. Two regular meetings a year. The annual meeting at time and place of State Medical Association and interim meeting six months later.

Arkansas Radiological Society
Secretary, Dr. Fred Hames, 511 National Bldg., Pine Bluff, Ark. Meets every three months and also at time and place of State Medical Association.

Atlanta Radiological Society
Secretary, Dr. Albert A. Rayle, Jr., 478 Peachtree St., N.E., Atlanta, Ga. Meets monthly, except during three summer months, on second Friday evening.

Brooklyn Roentgen Ray Society
Secretary, Dr. J. J. Daversa, 345 75th St., Brooklyn, N. Y. Meets monthly fourth Tuesday, October through April.

Buffalo Radiological Society
Secretary, Dr. Mario C. Gian, 610 Niagara St., Buffalo, N. Y. Meets second Monday evening each month, October to May inclusive.

Central New York Roentgen Ray Society
Secretary, Dr. Dwight V. Needham, 608 E. Genesee St., Syracuse N. Y. Meets January, May, November.

Central Ohio Radiological Society
Secretary, Dr. F. A. Riebel, 15 West Goodale St., Columbus, Ohio. Meets at 6:30 P.M. on second Thursday of October, December, February, April, and June at Columbus Athletic Club, Columbus, Ohio.

Chicago Roentgen Society
Secretary, Dr. Elbert K. Lewis, 6337 S. Harvard Ave., Chicago, Ill. Meets second Thursday of each month, October to April inclusive at the University Club.

Cleveland Radiological Society
Secretary, Dr. Mortimer Lubert, 10515 Carnegie Ave., Cleveland 6, Ohio. Meetings at 6:45 P.M. on fourth Monday of each month from October to April.

Colorado Radiological Society
Secretary, Dr. Parker Allen, Children's Hospital, Denver, Colo. Meets third Friday of each month at University of Colorado Medical Center or at Denver Athletic Club.

Connecticut Valley Radiologic Society
Secretary, Dr. B. B. Alicandri, 78 Wayne St., Springfield, Mass. Meets second Friday October and April.

Dallas-Fort Worth Radiological Club
Secretary, Dr. O. H. Grunow, 650 Fifth Ave., Fort Worth, Texas. Meets monthly, third Monday, at Greater Fort Worth International Airport at 6:30 P.M.

Detroit Roentgen Ray and Radium Society
Secretary, Dr. E. F. Lang, Harper Hospital, Detroit, Mich. Meets monthly first Thursday, Oct. through May, at David Whitney House, 4421 Woodward Ave., at 6:30 P.M.

East Bay Roentgen Society
Secretary, Dr. Dan Tucker, 434 30th St., Oakland 9, Calif. Meets first Thursday each month at Peralta Hospital, Oakland.

Florida Radiological Society
Secretary, Dr. J. T. Shelden, Box 1021, Lakeland, Fla. Meets twice annually, in the spring with the annual State Society meeting, and in the fall.

Georgia Radiological Society
Secretary, Dr. Robert M. Tankesley, 218 Doctors Bldg., Atlanta, Ga. Meets in mid-winter and at annual meeting of Medical Association of Georgia in the spring.

Greater Miami Radiological Society
Secretary, Dr. R. D. Shapiro, 541 Lincoln Rd., Miami Beach, Fla Meets monthly at various South Florida Hospitals.

Houston Radiological Society
Secretary, Dr. Harry Fishbein, 324 Medical Arts Bldg., Houston 2, Texas. Meets fourth Monday each month at Hermann Hospital.

Idaho State Radiological Society
Secretary, Dr. Alfred M. Stone, St. Lukes Hospital, Boise, Idaho. Meets annually at same time as Idaho State Medical Association.

Illinois Radiological Society
Secretary, Dr. Stephen L. Casper, 1101 Maine St., Quincy, Ill. Meets three times a year.

Indiana Roentgen Society
Secretary, Dr. John A. Robb, 238 Hume-Mansur Bldg., Indianapolis 4. Meets first Sunday in May and during fall meeting of Indiana State Medical Association.

Iowa Radiological Society
Secretary, Dr. James T. McMillan, 1104 Bankers Trust Bldg., Des Moines, Iowa. Luncheon and business meeting during annual session of Iowa State Medical Society. The scientific section is held in the autumn.

Kansas Radiological Society
Secretary Dr. A. M. Cherner, Hays, Kansas. Meets in spring with State Medical Society, and in winter on call.

Kentucky Radiological Society
Secretary, Dr. David Shapiro, 323 East Chestnut St., Louisville 2, Ky. Meets monthly on second Friday at Seelbach Hotel, Louisville.

Kings County Radiological Society
Secretary, Dr. Solomon Maranov, 1450 51st St., Brooklyn 19, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:45 P.M.

Los Angeles Radiological Society
Secretary, Dr. Oscar Harvey, 3741 Stocker St., Los Angeles 8, Calif. Meets second Wednesday each month at Los Angeles County Medical Association Building, Los Angeles.

* Secretaries of societies are requested to send timely information promptly to the Editor.

Maine Radiological Society
Secretary, Dr. Jack Spencer, Maine General Hospital, Portland 4, Maine. Meets in early spring, June and fall.

Maryland Radiological Society
Secretary-Treasurer, Dr. Paul W. Roman, 1810 Eutaw Place, Baltimore 17, Maryland.

Miami Valley Radiological Society
Secretary, Dr. G. A. Nicoll, 134 Apple St., Dayton, Ohio. Meets second Friday of fall and winter months.

Mid-Hudson Radiological Society
Secretary, Dr. J. W. Walton, Horton Memorial Hospital, Middletown, N. Y. Meets 8:30 P.M., fourth Tuesday each month, September to May.

Milwaukee Roentgen Ray Society
Secretary, Dr. T. J. Pfeffer, 839 N. Marshall St., Milwaukee 2, Wis. Meets monthly on second Monday at University Club.

Minnesota Radiological Society
Secretary, Dr. John R. Hodgson, Mayo Clinic, Rochester, Minn. Meets three times annually, once at time of State Med. Assn., and in spring and fall.

Mississippi Radiological Society
Secretary, Dr. John W. Evans, 117 N. President St., Jackson, Miss. Meets third Thursday of each month at the Rotisserie Restaurant at 6:30 P.M.

Montana Radiological Society
Secretary, Dr. Grant P. Raitt, Suite 413 Medical Arts Bldg., Billings, Montana. Meets at least once a year.

Nassau Radiological Society
Secretary, Dr. Frank Huber, Hempstead, N. Y. Meets second Tuesday of the month in February, April, June, October and December.

Nebraska Radiological Society
Secretary, Dr. J. F. Kelly, Jr., 816 Medical Arts Bldg., Omaha, Nebr. Meets third Wednesday of each month at 6 P.M. in Omaha or Lincoln.

New England Roentgen Ray Society
Secretary, Dr. Stanley M. Wyman, Massachusetts General Hospital, Boston, Mass. Meets monthly on third Friday, Harvard Club.

New Hampshire Roentgen Ray Society
Secretary, Dr. A. C. Johnston, Elliott Community Hospital, Keene, N. H. Meets four to six times yearly.

New York Roentgen Society
Secretary, Dr. J. R. Freid, 1049 Park Ave., New York 28, N. Y. Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

North Carolina Radiological Society
Secretary, Dr. W. C. Sternbergh, Charlotte Memorial Hospital, Charlotte, N. C. Meets in May and October.

North Dakota Radiological Society
Secretary, Dr. C. O. Heilman, 807 Broadway, Fargo. Meetings by announcement.

North Florida Radiological Society
Secretary, Dr. Ivan Isaacs, 1485 Cheshire Road, Jacksonville, Florida. Meets quarterly in March, June, September and December.

Northeastern New York Radiological Society
Secretary, Dr. D. H. Baxter, Albany Hospital, Albany, N. Y. Meets in Albany area on second Wednesdays of October, November, March and April.

Northern California Radiological Society
Secretary, Dr. H. B. Stewart, 2920 Capitol Ave., Sacramento, Calif. Meets at dinner last Monday of each month, September to June.

Ohio State Radiological Society
Secretary, Dr. M. M. Thompson, Jr., 319 Toledo Medical Bldg., Toledo 2, Ohio.

Oklahoma State Radiological Society
Secretary, Dr. John R. Danstrom, Medical Arts Bldg., Oklahoma City, Okla. Three regular meetings annually.

Oregon Radiological Society
Secretary, Dr. J. W. Loomis, 919 Taylor St. Bldg., Portland 5, Oregon. Meets monthly from October to June on the second Wednesday of each month at 8:00 P.M. at the University Club.

Orleans Parish Radiological Society
Secretary, Dr. Joseph V. Schlosser, Charity Hospital, New Orleans 13, La. Meets first Tuesday of each month.

Pacific Northwest Radiological Society
Secretary, Dr. J. R. Raines, 214 Medical-Dental Bldg., Portland 5, Oregon. Meets annually in May.

Pacific Roentgen Society
Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

Pennsylvania Radiological Society
Secretary, Dr. J. M. Converse 416 Pine St., Williamsport. Next annual meeting at Bedford Springs Hotel, Bedford, Penna., May 14 and 15, 1954.

Philadelphia Roentgen Ray Society
Secretary, Dr. H. M. Stauffer, Temple University Hospital, Philadelphia 40, Pa. Meets first Thursday of each month, at 5 P.M., from October to May in Thompson Hall, College of Physicians.

Pittsburgh Roentgen Society
Secretary, Dr. Donald H. Rice, Western Pennsylvania Hospital, Pittsburgh 24, Pa. Meets second Wednesday of month, October through June at Hotel Roosevelt.

Radiological Section, Baltimore Medical Society
Secretary, Dr. H. Leonard Warres, 2337 Eutaw Place, Baltimore 17, Md. Meets third Tuesday each month, September to May, inclusive.

Radiological Section, Connecticut Medical Society
Secretary, Dr. William A. Goodrich, 85 Jefferson St., Hartford 6, Conn. Meetings are held bi-monthly.

Radiological Section, Southern Medical Association
Secretary, Dr. Roy G. Giles, Temple, Texas.

Radiological Society of Greater Cincinnati
Secretary, Dr. Chapin Hawley, 927 Carew Tower, Cincinnati 2, Ohio. Meets monthly from September to June on first Monday of each month at 7:30 P.M. at the Cincinnati General Hospital.

Radiological Society of Hawaii
Secretary, Dr. P. S. Arthur, Young Hotel Bldg., Honolulu 13, T. H. Meets third Friday of each month at a place designated by the Secretary.

Radiological Society of Kansas City
Secretary, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month.

Radiological Society of Louisiana
Secretary, Dr. J. T. Brierre, 700 Audubon Bldg., New Orleans. Meets annually during Louisiana State Medical Society Meeting.

Radiological Society of New Jersey
Secretary, Dr. Carye-Belle Henle, 195 North 7th St., Newark, N. J. Meets at Atlantic City at time of State Medical Society and in November in Newark, N. J.

Radiological Society of Southern California
Secretary, Dr. George Jacobson, 1200 N. State St., Los Angeles 33, Calif.

Richmond County Radiological Society
Secretary, Dr. W. F. Hamilton, Jr., University Hospital, Augusta, Ga. Meets first Thursday of each month at various hospitals.

Rochester Roentgen Ray Society, Rochester, N. Y.
Secretary, Dr. Henry H. Forsyth, Jr., 40 Meigs St., Rochester, N. Y. Meets at 8:15 P.M. on the last Monday of each month, September through May, at Strong Memorial Hospital.

Rocky Mountain Radiological Society
Secretary, Dr. John H. Freed, 4200 East Ninth St., Denver 7, Colo. Meets at Shirley-Savov Hotel, Denver, Colo., Aug. 19–21, 1954.

St. Louis Society of Radiologists
Secretary, Dr. W. B. Seaman, 510 South Kingshighway, St. Louis 10, Mo. Meets fourth Wednesday each month, except June, July, August and September.

SAN ANTONIO-MILITARY RADIOLOGICAL SOCIETY
Secretary, Dr. Hugo F. Elmendorf, Jr., 730 Medical Arts Bldg., San Antonio 5, Texas. Meets Brook Army Medical Center Officers Mess first Monday of each month.

SAN DIEGO RADIOLOGICAL SOCIETY
Secretary, Dr. C. W. Bruner, 2456 Fourth Ave., San Diego 1, Calif. Meets first Wednesday of each month at the University Club.

SAN FRANCISCO RADIOLOGICAL SOCIETY
Secretary, Dr. I. J. Miller, 2680 Ocean Avenue, San Francisco 27, Calif. Meets quarterly.

SECTION ON RADIOLOGY, CALIFORNIA MEDICAL ASSOCIATION
Secretary, Dr. H. R. Morris, 1027 "D" St., San Bernardino, Calif.

SECTION ON RADIOLOGY, MEDICAL SOCIETY OF THE DISTRICT OF COLUMBIA
Secretary, Dr. John A. Long, 1801 K St., N.W., Washington 6, D. C. Meets Medical Society Library, third Wednesday of January, March, May and October at 8:00 P.M.

SECTION ON RADIOLOGY, ILLINOIS STATE MEDICAL SOCIETY
Secretary, Dr. George E. Irwin, Jr., 703 N. East St., Bloomington, Ill.

SHREVEPORT RADIOLOGICAL CLUB
Secretary, W. R. Harwell, 608 Travis St., Shreveport, La. Meets monthly on third Wednesday, at 7:30 P.M. September to May inclusive.

SOUTH BAY RADIOLOGICAL SOCIETY
Secretary, Dr. J. J. McCort, Santa Clara County Hospital, San Jose, Calif. Meets second Wednesday each month.

SOUTH CAROLINA RADIOLOGICAL SOCIETY
Secretary, Dr. William A. Klauber, Self Memorial Hospital, Greenwood, S. C. One meeting with South Carolina Medical Association in May, others arranged by President.

TENNESSEE RADIOLOGICAL SOCIETY
Secretary, Dr. G. K. Henshall, 311 Medical Arts Bldg., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

TEXAS RADIOLOGICAL SOCIETY
Secretary, Dr. R. P. O'Bannon, 650 Fifth Ave., Fort Worth 4, Texas.

TRI-STATE RADIOLOGICAL SOCIETY
Secretary, Dr. S. N. Tager, 219 Walnut St., Evansville, Ind. Meets last Wednesday of Oct., Jan., March and May, 8:00 P.M. at Elks' Club in Evansville.

UNIVERSITY OF MICHIGAN DEPARTMENT OF ROENTGENOLOGY STAFF MEETING
Meets each Monday evening from September to June, at 7:00 P.M. at University Hospital.

UNIVERSITY OF WISCONSIN RADIOLOGICAL CONFERENCE
Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets first and third Thursdays 4:00 to 5:00 P.M., September to May, Service Memorial Institute.

UTAH STATE RADIOLOGICAL SOCIETY
Secretary, Dr. Angus K. Wilson, 343 S. Main St., Salt Lake City 1, Utah. Meets fourth Wednesday in January, March, May, September and November at Holy Cross Hospital.

VIRGINIA RADIOLOGICAL SOCIETY
Secretary, Dr. P. B. Parsons, Norfolk General Hospital, Norfolk, Va. Meets annually in October.

WASHINGTON STATE RADIOLOGICAL SOCIETY
Secretary, Dr. Eva L. Gilbertson, 1317 Marion St., Seattle 4, Wash. Meets fourth Monday of each month from September through May at 610 Pine St., Seattle.

WEST VIRGINIA RADIOLOGICAL SOCIETY
Secretary, Dr. W. Paul Elkin, 515 Medical Arts Bldg., Charleston, W. Va. Meets concurrently with annual meeting of West Virginia State Medical Society; other meetings arranged by program committee.

WESTCHESTER RADIOLOGICAL SOCIETY
Secretary, Dr. M. G. Priestman, New Rochelle Hospital, New Rochelle, N.Y. Meets on third Tuesday of January and October and on two other dates.

WISCONSIN RADIOLOGICAL SOCIETY
Secretary, Dr. W. W. Moir, 309 Geele Ave., Sheboygan, Wis. Special meetings held during year; annual meeting each spring at Madison, Wis.

X-RAY STUDY CLUB OF SAN FRANCISCO
Secretary, Dr. Wm. W. Saunders, Veterans Administration Hospital, San Francisco 21, Calif. Meets monthly, third Thursday, at 7:45 P.M., Lane Hall, Stanford University Hospital.

CUBA, MEXICO, PUERTO RICO AND CENTRAL AMERICA

SOCIEDAD DE RADIOLOGÍA Y FISIOTERAPIA DE CUBA
President, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

SOCIEDAD MEXICANA DE RADIOLOGÍA, A. C.
Secretary General, Dr. Eugenio Toussaint, Calle del Oro No. 15, Mexico 7, D.F. Meets first Monday of each month.

ASOCIACIÓN PUERTORRIQUEÑA DE RADIOLOGÍA
Secretary, Dr. Rafael A. Blanes, Ave. Ponce de Leon 1175, Santurce, P. R.

SOCIEDAD RADIOLÓGICA PANAMEÑA
Secretary, Dr. L. Arrieta Sanchez, Apartado No. 86, Panama, R. de P. Meets monthly in a department of radiology of a local hospital, chosen at preceding meeting.

BRITISH EMPIRE

ASSOCIATION OF RADIOLOGISTS OF THE PROVINCE OF QUEBEC
Secretary, Dr. J.-P. Jean, 4039 Tupper St., Westmount, Que.

BRITISH INSTITUTE OF RADIOLOGY INCORPORATED WITH THE RÖNTGEN SOCIETY
Ordinary meeting, on the Thursday preceding the third Friday, October to May at 8:15 P.M.
Medical Members' meeting, on third Friday in each month at 5:00 P.M., 32 Welbeck St., London, W 1.

FACULTY OF RADIOLOGISTS
Honorary Secretary, Dr. J. F. Bromley, 45, Lincoln's Inn Fields, London, W.C.2, England.

SECTION OF RADIOLOGY OF THE ROYAL SOCIETY OF MEDICINE (CONFINED TO MEDICAL MEMBERS)
Meets third Friday each month at 4:45 P.M. at the Royal Society of Medicine, 1 Wimpole St., London.

CANADIAN ASSOCIATION OF RADIOLOGISTS
Honorary Secretary-Treasurer, Dr. D. L. McRae, Suite 305, 1555 Summerhill Avenue, Montreal 25, Que. Meetings January and June.

SECTION OF RADIOLOGY, CANADIAN MEDICAL ASSOCIATION
Secretary, Dr. C. M. Jones, Inglis St., Ext. Halifax, N. S.

SOCIÉTÉ CANADIENNE-FRANÇAISE D'ELECTRO-RADIOLOGIE MÉDICALES
General Secretary, Dr. Ls Ivan Vallée, 1058 rue St-Denis, Montreal 18, Canada. Meets third Saturday each month.

COLLEGE OF RADIOLOGISTS (AUSTRALIA AND NEW ZEALAND)
Honorary Secretary, Dr. Alan R. Colwell, c/o British Medical Agency, 135 Macquarie St., Sydney, N.S.W.

SOUTH AMERICA

ASOCIACION ARGENTINA DE RADIOLOGIA
Secretary, Dr. Lidio G. Mocsa, Avda. Gral Paz 151, Córdoba, Argentina. Meetings held monthly.

SOCIEDAD ARGENTINA DE RADIOLOGIA, JUNTA CENTRAL, BUENOS AIRES
Secretary, Dr. Oscar F. Noguera, Santa Fe 1171, Buenos Aires. Meetings are held monthly.

SOCIEDAD ARGENTINA DE RADIOLOGIA, FILIAL DEL LITORAL, SEDE, ROSARIO
President, Dr. Francisco P. Cifarelli. Meets monthly second Wednesday, 19 ha 663 Italia St., Rosario, Santa Fe.

SOCIEDAD ARGENTINA DE RADIOLOGIA, FILIAL DEL SUR, SEDE, LA PLATA
President, Prof. Dr. Jose P. Uslenghi, La Plata. Meets monthly.

Sociedad Argentina de Radiologia, Filial del Centro Sede, Cordoba
President, Prof. Dr. David L. Caro, Corro 86, Cordoba. Meets monthly.

Sociedad Argentina de Radiologia, Filial del Norte, Sede, Tucuman
President, Dr. Julio Mendez Valladares, Rivadavia 358, Tucuman. Meets monthly.

Sociedad Argentina de Radiologia, Filial de Cuyo Sede, Mendoza.
President, Dr. J. A. Orfila, Hospital Central, Mendoza. Meets monthly.

Sociedade Brasileira de Radiologia Medica
Secretary, Dr. Nicola Caminha, Av. Mem de Sa, Rio de Janeiro, Brazil. Meets monthly, except during January, February and March.

Sociedade Brasileira de Radioterapia
Secretary, Dr. Oscar Rocha von Pfuhl, Av. Brigadeiro Luiz Antonio, 644 São Paulo, Brazil. Meets monthly on second Wednesday at 9:00 P.M. in São Paulo at Av. Brigadeiro Luiz Antonio, 644.

Sociedad Colombiana de Radiologia
Secretary, Dr. Luis E. Lozano B., Carrera 12 No. 20–69, 6º piso, Bogota, Colombia. Meets last Thursday of each month.

Sociedad Peruana de Radiologia
Secretary, Dr. Julio Bedoya Paredes, Apartado 2306, Lima, Peru. Meets monthly except during January, February and March, at Asociación Médica Peruana "Daniel A. Carrión," Villalta, 218, Lima.

Sociedad de Radiologica, Cancerologia y Fisica Medica del Uruguay
Secretary, Dr. Arias Bellini, Av. Agraciada 1464, Piso 13, Montevideo, Uruguay.

Continental Europe

Société Belge de Radiologie
General Secretary, Dr. S. Masy, 111 Avenue des Allies, Louvain, Belgium. Meets monthly, second Sunday at Maison des Médecins, Brussels.

Société Française d'Electro-Radiologie Médicale, and its branches: Société du Sud-Ouest, du Littoral Méditerranéen, du Centre et du Lyonnais, de l'Ouest, de l'Est, et d'Alger et d'Afrique du Nord
Secretary-General, Dr. A. Dariaux, 9 bis, Boulevard Rochechouart, Paris IXe, France.

Ceskoslovensk společnost pro rëntgenologii a Radiologii v Praze
Secretary, Dr. Roman Bláha, Praha XII, stát. nemocnice, Czechoslovakia. Meets monthly except during July, August, and September. Annual general meeting.

Deutsche Röntgen-Gesellschaft
Secretary, Dr. med. Peter Kröker, Evangelisches Krankenhaus, Huyssens Stiftung, (22a) Essen. Annual meeting, Sept. 5–8, 1954, Wiesbaden, Germany.

Societa Italiana di Radiologia Medica
Secretary, Prof. Mario Ponzio, Ospedale Mauriziano. Torino, Italy. Meets biannually.

Nederlandse Vereniging voor Electrologie en Roentgenologie
Secretary, Dr. B. J. Rethmeier, Bornsestraat 378, Almelo, Netherlands.

Polish Society of Radiology
Secretary, Dr L. Zgliczynski, 59 Nowogrodzka St., Warsaw, Poland.

Gdansk Section, Polish Society of Radiology
Secretary, Dr. A. Smigielska, Akademia Lekarska, Gdansk. Meets monthly last Sunday at 10:30, X-Ray Dept.. Akademia Gdansk.

Wroclaw Section, Polish Society of Radiology
Secretary, Dr. R. Marciniak, Akad. Medyczna Wroclaw, 68 Curie-Sklodowska St., Wroclaw, Poland. Meets first Sunday of each month, X-Ray Department, Akademia Medyczna Wroclaw.

Societatea Romana de Radiologie si Electrologie
Secretary, Dr. Oscar Meller, Str. Banual Mărăcine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

All-Russian Roentgen Ray Association, Leningrad
USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

Scandinavian Roentgen Societies
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

Sociedad Espanola de Radiologia y Electrologia
Secretary, Dr. J. Martin-Crespo, Fuencarral, 7. Madrid, Spain. Meets monthly in Madrid.

Schweizerische Röntgen-Gesellschaft (Société Suisse de Radiologie)
Secretary, Dr. Max Hopf, Effingerstrasse 47, Bern, Switzerland.

India

Indian Radiological Association
Secretary, Dr. R. F. Sethna, Navsari Building, Hornby Road, Bombay 1, India.

BRITISH INSTITUTE OF RADIOLOGY

Arrangements have been made for the Annual Congress and Exhibition of the British Institute of Radiology to take place during the week commencing November 22, 1954.

The scientific meetings will be held on November 24, 25 and 26, 1954, in the Lecture Room of the New Horticultural Hall, Vincent Square, London, and in the Drill Hall of the Westminster Dragoons, Elverton Street, London. The scientific exhibition will be housed in the Old Horticultural Hall.

The program of the Congress is being planned on similar lines to the previous years with symposia on diagnostic, therapeutic, physics and radiobiological subjects, with the Mackenzie Davidson Memorial Lecture on the evening of November 25 and a dinner on the evening of November 26.

For the first time since 1938 the British X-ray Industry is to organize an exhibition of roentgenological equipment and materials in conjunction with the Annual Congress of the British Institute of Radiology. (The 1950 Exhibition was of course associated with the International Congress of Radiology.)

The Exhibition will be held in the Old Hall of the Royal Horticultural Society, which is conveniently close to the New Hall and to the Westminster Dragoons' Drill Hall. Full support has been promised by the Industry, some eighteen firms having made provisional application for space. The Exhibition will open at 2 P.M. on Tuesday, November 23, and on the following three days at 9 A.M. It will remain open each day until 6 P.M., except on Thursday when the closing time is extended to 8 P.M. The Organizing Secretary is Mr. A. Beetlestone.

APPLICATIONS FOR GRANTS IN CANCER RESEARCH

Acting for the American Cancer Society, the Committee on Growth of the National Research Council is accepting applications for grants-in-aid for cancer research in the United States. Applications received before October 1, 1954, will be considered during the winter, and grants recommended at that time become effective on July 1, 1955. Investigators now receiving support will be notified individually regarding their application for renewal.

The Committee feels that an understanding of cancer depends upon a deeper insight into the nature of the growth process, normal and malignant. Therefore, the scope of the research program is broad and includes, in addition to clinical investigations on cancer, fundamental studies in the fields of cellular physiology, morphogenesis, genetics, virology, biochemistry, metabolism, nutrition, cytochemistry, physics, radiobiology, chemotherapy, endocrinology and environmental cancer.

Application blanks and additional information may be obtained from the Executive Secretary, Committee on Growth, National Research Council, 2101 Constitution Avenue, N.W., Washington 25, D. C.

RADIOLOGICAL HEALTH TRAINING PROGRAM

In recognition of the increased use of radiation and the associated health protection problems, the Public Health Service, U. S. Department of Health, Education, and Welfare, sponsors a radiological health training program. The purpose of the program is to indoctrinate public health workers with the significance of ionizing radiations, the environmental and occupational hazards attendant on their use, and recommended procedures for minimizing such hazards. The training program is presented at the Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio. It is designed primarily for professional personnel of State and local health departments, but a limited number of qualified applicants from other governmental agencies and industry will be welcome.

The following courses will be presented in 1954–1955:

Nov. 1–5 ..... Problems of Radioactivity in Waterworks
Jan. 10–21 ..... Basic Course in Radiological Health
Jan. 24–Feb. 4 ..... Occupational Radiation Protection
March 7–10 ..... Radiation Hygiene—Preventive Medical Aspects
April 18–29 ..... Basic Course in Radiological Health
May 2–13 ..... Environmental Radiation Sanitation Course
May 16–20 ..... Problems of Radioactivity in Waterworks

For further information address: Chief, Radiological Health Training Section, Robert A. Taft Sanitary Engineering Center, 4676 Columbia Parkway, Cincinnati 26, Ohio.

ARIZONA RADIOLOGICAL SOCIETY

At the recent annual meeting of the Arizona Radiological Society, the following officers were elected for the coming year: *President*, Dr. Walter T. Hileman, Tucson, Arizona; *Vice President*, Dr. John W. Kennedy, Phoenix, Arizona; *Secretary-Treasurer*, Dr. R. Lee Foster, 507 Professional Building, Phoenix, Arizona.

MARYLAND RADIOLOGICAL SOCIETY

The second annual meeting of the Maryland Radiological Society was held at Hagerstown, Maryland, on May 15, 1954. This was a joint meeting with the Radiological Section of the Baltimore City Medical Society. A number of interesting papers were presented during the morning and afternoon. In the evening, following the annual dinner, the guest speaker was Dr. Ralph E. Lapp, Science Consultant, Director of the Nuclear Science Service, Washington, D. C. His subject was "Atomic Defense."

The following officers were elected for the year 1954–1955: *President*, Dr. E. Thrall Campbell, Hagerstown, Maryland; *Vice President*, Dr. Webster H. Brown, Baltimore, Maryland; *Secretary-Treasurer*, Dr. Paul W. Roman, 1810 Eutaw Place, Baltimore 17, Maryland.

NORTH FLORIDA RADIOLOGICAL SOCIETY

The North Florida Radiological Society has recently been organized with Dr. Thos. H. Lipscomb, Jacksonville, *President*, and Dr. Ivan Isaacs, 1485 Cheshire Road, Jacksonville, Florida, *Secretary-Treasurer*. The meetings are to be held quarterly, in March, June, September and December.

OHIO STATE RADIOLOGICAL SOCIETY

The annual meeting of the Ohio State Radiological Society was held in Toledo, Ohio, May 21 to 23, 1954. The following officers were elected for the ensuing year: *President*, Dr. Willis Peck; *Vice President*, Dr. George Krause; *Secretary*, Dr. M. M. Thompson, Jr., 319 Toledo Medical Building, Toledo 2, Ohio; *Treasurer*, Dr. Paul Jones. The next annual meeting will be in the latter part of May, 1955, in Akron, Ohio.

PACIFIC NORTHWEST RADIOLOGICAL SOCIETY

The seventh annual meeting of the Pacific Northwest Radiological Society was held at Harrison Hot Springs Hotel, British Columbia, May 13 to 16, 1954. It was under the direction of President William Sloan of Vancouver, B. C., and Dr. D. R. McRae of Montreal was the principal guest speaker. Dr. Melvin Aspray of Spokane was installed as president. Newly elected officers are: *President-Elect*, Dr. Sydney J. Hawley, Seattle, Washington; *First Vice President*, Dr. J. M. Madill; *Second Vice President*, Dr. Milo T. Harris, Spokane, Washington; *Secretary-Treasurer*, Dr. J. Richard Raines, 214 Medical-Dental Building, Portland 5, Oregon.

PITTSBURGH ROENTGEN SOCIETY

At the meeting of the Pittsburgh Roentgen Society held June 9, 1954, the following officers were elected: *President*, Dr. Peter M. Feltwell, Jr.; *Vice President*, Dr. Karl J. Myers; *Secretary*, Dr. Donald H. Rice, 4800 Friendship Avenue, Pittsburgh 24, Pennsylvania; *Treasurer*, Dr. Newton Hornick. The regular meetings are held on the second Wednesday of the month October through June at the Hotel Roosevelt.

RADIOLOGICAL SOCIETY OF NEW JERSEY

At the annual meeting of the Radiological Society of New Jersey held on May 19, 1954, the following officers were elected for the year 1954–1955: *President*, Dr. Nicholas G. Demy; *Vice President*, Dr. Salomon Silvera; *Secretary*, Dr. Carye-Belle Henle, 195 N. 7th Street, Newark, New Jersey; *Treasurer*, Dr. Leonard S. Ellenbogen. The Society meets at Atlantic City at the time of the State Medical Society meeting and in November in Newark, New Jersey.

SECTION ON RADIOLOGY OF THE MEDICAL SOCIETY OF THE DISTRICT OF COLUMBIA

At a recent meeting of the Section on Radiology of the Medical Society of the District of Columbia the following officers were elected for 1954–1955: *President*, Dr. Karl C. Corley; *Vice President*, Dr. Francis C. Allman; *Secretary-Treasurer*, Dr. John A. Long, 1801 K St., N. W., Washington 6, D. C.

BOOK REVIEWS

Books sent for review are acknowledged under. Books Received. This must be regarded as a sufficient return or the courtesy of the sender. Selections will be made for review in the interest of ournreaders as space permits.

Die zerebrale Angiographie. Von H. Krayenbühl, Professor für Neurochirurgie, Direktor der Neurochirurg, Universitätsklinik Zürich; und Hs. R. Richter, Assistent, der Neurochirurg, Universitätsklinik Zürich. Cloth. Price, DM 59.70. Pp. 217, with 100 illustrations. Georg Thieme, Diemershaldenstrasse, 47, Stuttgart, Germany (Grune & Stratton, Inc., New York, New York), 1952.

Since cerebral angiography was first practiced by Egas Moniz in 1927, the method has gained increasing popularity in this country. In fact, American radiologists, neurologists, and neurosurgeons have become foremost proponents of this diagnostic method. Dissemination of knowledge in the field has been hampered somewhat, however, by the lack of suitable and available reference works. Recently Ecker's volume on the normal cerebral angiogram has been received with enthusiasm; Krayenbühl and Richter's present publication should receive the same welcome.

An expansion of the section on cerebral angiography in "Lehrbuch der Röntgendiagnostik" by Schinz, Baensch, Friedl and Uehlinger, this monograph is probably the finest modern contribution to the serious study of the subject. Representing, as it does, the analysis of 1,500 angiographic examinations performed at the Neurosurgical Clinic of the University of Zürich, the presentation is complete in every respect. In the early sections of the volume are succinct discussions of the history of cerebral angiography, the technique of carotid and vertebral angiographic injection, the normal anatomy of cerebral arteries and veins, the physiology involved in cerebral vessel filling, vascular affections of the brain, and localization and diagnosis of space-occupying intracranial lesions. The succeeding 143 pages consist of an atlas of cerebral angiography in which an astounding variety of pathologic processes are demonstrated by beautiful angiograms. Each representative case is presented clinically and the angiographic signs explained, often with the aid of corresponding line drawings. On this basis alone the volume should be of inestimable value to the beginning student of cerebral angiography. Also the experienced worker undoubtedly will find these latter pages an unexcelled source of reference.

A rather complete world bibliography is appended to the text. The index is complete and accurate.

The general excellence of the text (written in rather easy scientific German) and the superb illustrations make "Cerebral Angiography" a monograph to be recommended without reservation.

Harold Fulton, M.D.

Die Angiographie zur Erkennung, Behandlung und Begutachtung peripherer Durchblutungsstörungen. Von Dr. med. habil. H. W. Pässler, Stadtobermedizinalrat, Chefarzt des Städt. Krankenhausen Leverkusen. Paper. Price, DM 29.70. Pp. 115, with 102 illustrations. Georg Thieme, Diemershaldenstrasse, 47, Stuttgart, Germany (Grune & Stratton, Inc., New York, New York), 1952.

In the sixty-seventh supplement to the *Fortschritte auf dem Gebiete der Röntgenstrahlen*, Pässler presents his experiences in the diagnosis and treatment of peripheral circulatory disturbances. The accent throughout the volume is upon the clinical diagnosis and correlation of clinical findings with results of angiographic studies, so that only a relatively few specialists will find the greater portion of the text of interest. However, of special value to the diagnostic radiologist is the section concerning the technique of percutaneous puncture of the femoral artery as practiced by the author, and his apparatus for controlled contrast injection and serial film studies. The type of peripheral arteriography illustrated has not been extensively used as a diagnostic adjunct to the study of peripheral arterial disease in this country, so that the detailed discussion of the methods of producing satisfactory arteriograms will be aid to anyone wishing to try the method. Short discussions of venography and aortography are included.

The arteriographic findings in Raynaud's disease, thromboangiitis obliterans (Buerger's dis-

ease), atherosclerosis, and arteriosclerosis are discussed and extensively reproduced in good quality prints. The emphasis placed on the exact determination of the extent of the narrowed or obliterated arterial segment and the degree of collateral circulation is well founded and supports the author's contention that for intelligent handling, especially surgical, of these affections angiography is quite necessary.

This monograph will be read with profit by physicians interested in peripheral vascular disease.

Harold Fulton, M.D.

Gastrointestinal X-ray Diagnosis. By Max Ritvo, M.D., Assistant Professor of Radiology, Harvard Medical School, etc.; and I. A. Shauffer, M.D., Instructor in Radiology, Harvard Medical School, etc. Cloth. Price, $20.00. Pp. 838, with 470 illustrations. Lea & Febiger, Washington Square, Philadelphia 6, Pennsylvania, 1952.

As stated by the authors in the preface, the purpose of this book is "to describe and discuss the lesions of the gastrointestinal tract and its related viscera which can be diagnosed by roentgen examination. It is now generally accepted that no clinical examination of the alimentary tract is complete without roentgen studies." This aim is very thoroughly and admirably achieved.

The book is divided into ten chapters which are as follows:

1. General considerations. 2. The pharynx and the esophagus. 3. The stomach. 4. The duodenum. 5. The jejunum and the ileum. 6. The colon. 7. The appendix. 8. The gallbladder and the liver. 9. The pancreas, spleen, mesentery, omentum, peritoneum and abdomen. 10. Hernia.

Each of these subjects is then taken up in the following manner:

The involved anatomy is summarized in a thorough yet concise manner. Next, the technique of the roentgen examination is detailed with a presentation of the opaque media involved and procedure to be followed in the roentgenoscopic and roentgenographic portions of an adequate examination. The authors include not only their own tested methods of procedure but also those used in other institutions. A discussion of all the diseases affecting the organ or organs under discussion is then undertaken. This is most complete and the pathogenesis, clinical manifestations and, in some instances, the treatment of the condition are included in addition to the roentgen manifestations. If there is a controversial aspect to any of the material, this is presented with all of the pertinent literature so that the reader may make a thorough evaluation of it. An extremely complete and up-to-date bibliography is furnished at the end of each chapter for the reader's reference, if further investigation of the subject is deemed desirable or necessary.

The book is well illustrated, all of the reproductions being excellent to demonstrate the pathological conditions under discussion. It is printed on glossy paper and the binding is adequate. It is highly recommended to all radiologists and should be of considerable interest to gastroenterologists.

Joseph O. Reed, M.D.

Les contusions du rein. Par L. Sabadini, Professeur de Clinique urologique à la Faculté de Médecine d'Alger, Chirurgien de l'Hôpital de Mustapha, Membre de l'Académie de Chirurgie, et J. Ducassou, Urologue des Hôpitaux (Alger). Paper. Price, 750 fr. Pp. 107, with 65 illustrations. Masson et Cie, 120, boulevard Saint-Germain, Paris 6, France, 1952.

In this monograph two urologists review the subject of the diagnosis and treatment of renal contusions. Their material consists of fifty cases: forty-eight men and two infants. It is their view that urological consultation should be promptly utilized and the patient not treated by the general surgeons who they infer may operate on clinical signs alone or supported by the unreliable evidence of excretory urography.

A number of cases are cited in which there is shown to be great disparity between the evidence given by excretory urography and that of retrograde pyelography. They stress the far greater precision of the latter method in providing a definitive diagnosis. They show how an intravenous study may falsely indicate a serious lesion of a kidney, and how it may conversely fail to show one. Nevertheless, they believe that intravenous urography should be practiced in these injuries but only to give general information, to be followed shortly by retrograde pyelographic analysis of the indicated side.

The authors stress the need of roentgenoscopy to determine immobility of a diaphragmatic cupola and of thoracic roentgenograms

to determine elevation of a hemidiaphragm. Also, films of the abdomen and lumbar spine are needed for further evidence of abnormality that may be seen on such plain films.

Careful study is required of the general condition of the patient to determine if there are associated injuries to the liver or spleen. These may require urgent intervention. In the experience of the authors, with respect to kidney contusions, since their orientation to urology in 1943, out of thirty-three cases only four have been operated upon, with two requiring nephrectomy and two suturing.

These writers conclude that thorough roentgenological study under the direction of a urologist should be practiced in all cases of suspected renal trauma and the patient should be followed by repeated retrograde and excretory pyelographic studies. Operative intervention will rarely be found necessary if the exact status of the renal structure is revealed by precise roentgenologic methods.

Lewis E. Etter, M.D.

Urethrography in the Male with a Highly Viscous, Water-soluble Contrast Medium, Umbradil-viscous U. Acta radiologica, Supplement 95. By Olallo Morales and Ragnar Romanus. Paper. Price, Sw. Kr. 20:-. Pp. 91, with 30 illustrations. Acta radiologica, Stockholm 2, Sweden, 1952.

The authors of this monograph have dealt exhaustively with radiopaque media and techniques used in contrast roentgen study of the male urethra and bladder base. While the initial chapter describing the physical properties of fluids will doubtless prove to be somewhat technical for demands of the physician, the succeeding section covering physical considerations of importance in the physiology of bladder and urethral contrast filling should be of practical interest to all in this field. The authors emphasize here and elsewhere in the study the value of the evacuation films in examination of of the posterior urethra following voluntary contraction of the pelvic floor.

Next, they describe, compare and contrast the various opaque media used in urethral contrast studies. As the title indicates, the authors' preference is for a viscous, water soluble preparation of umbradil (diodrast) in an aqueous carboxymethylcellulose base with added local anesthetic (xylocain).

The remainder of the monograph concerns itself with the actual technique of urethrography and comparison of the findings using the viscous medium (umbradil viscous U) with low viscosity preparations. Arguments stressing the superiority of viscous media, particularly in study of the posterior urethra, are amply documented by reproductions of urethrograms employing both thin and viscous solutions in identical cases.

F. R. Birkhill, M.D.

Mass, Lipids, Pentose Nucleoproteins and Proteins Determined in Nerve Cells by X-ray Microradiography. Acta radiologica, Supplement 94. By Sven-Olof Brattgård and Holger Hydén. Paper. Price, Sw. Kr. 15:-. Pp. 48, with 22 illustrations. Acta radiologica, Stockholm 2, Sweden, 1952.

This monograph describes in detail the principles, procedures and applications of the method of Engström and Lindström for histochemical analysis using soft roentgen rays in the wavelength region of 8–10 Å. The method permits a quantitative mass determination of a given cell component in terms of dry cell weight. Repeated extractions using appropriate reagents, followed by successive mass determinations, allows the individual cell components to be calculated by difference at the end of each step.

The method employs roentgen rays generated at 3 kv. filtered through a 9 μ aluminum foil filter. The specimens, appropriately mounted on Lippmann film, are exposed to the roentgen source together with reference standards constructed from varying thicknesses of nitrocellulose foils. The densities of the resulting roentgenograms are then measured on a microphotometer. Correlation of image densities of the sample with those obtained from the reference standards permits calculation of sample mass by virtue of the fact that the two systems, sample and reference foils, have mass absorption coefficients of similar wavelength dependence at 8–10 Å.

The authors employ chloroform extraction for lipids and digestion by crystalline ribonuclease to free the cell of pentose nucleoproteins. After these extractions the remaining cell mass represents the residual cell proteins.

Finally, the authors present data resulting from the analysis of nerve cells including Deiters' cells, spinal ganglion cells and Purkinje's cells.

F. R. Birkhill, M.D.

Radioisotopía Clínica. By F. Manchón, A. Modolell, A. Miguel, A. Subias, and J. Farrerons. Cloth. Pp. 283, with 47 illustrations. Publicaciones médicas, José Janés, Editor, Muntaner, 316, Barcelona, Spain, 1951.

In this little book the authors discuss the foundations of the application of radioactive isotopes in medical practice which they call "Clinical Radioisotopy."

The subject, which is presented in a scholarly manner, is divided into twelve chapters, schematic diagrams being used mainly for illustration. Some of the more important chapters deal with the physical principles, biological action and production of the radioactive isotopes, the therapeutic application of radioiodine and radiophosphorus and certain diagnostic tracer studies. A whole chapter is also devoted to the hazards of the use of the radioactive isotopes and their prevention.

Professor Dr. M. Soriano in his preface to the book states that in no other branch of medicine is there need for greater caution and more assiduous work than in clinical isotope therapy and there can be no doubt that the authors have met these requirements fully in approaching their subject.

The book serves a good purpose as a valuable guide in a rapidly expanding field of scientific development.

T. Leucutia, M.D.

Ultraviolet Radiation. By Lewis R. Koller, Ph.D., Research Associate, General Electric Research Laboratory, Schenectady, New York. Cloth. Price, $6.50. Pp. 270, with numerous illustrations. John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, New York, 1952.

This book by one of the members of the staff of the General Electric Research Laboratory in Schenectady fills a need which has been urgently felt for a book on the physics of ultraviolet radiation. In perhaps no other field of physical medicine is intelligent clinical application so closely related to the underlying physics as in ultraviolet radiation. The author discusses the different sources of ultraviolet transmission and reflection, and measuring instruments for ultraviolet radiation. There is one chapter of approximately 40 pages devoted to the applications of ultraviolet radiation. In this chapter the author discusses the development of erythema, of pigmentation, the production of vitamin D, the germicidal effect on bacteria, virus and other organisms. He discusses the disinfection of air and water, fluorescent lamps, blacklite and suntan lamps. In all these subjects the author carefully avoids medical indications. Even under a subheading called "Ultraviolet in the Prevention and Cure of Rickets," the author limits himself wisely to scientific data without trying to take up the medical aspects. He makes no attempt to show that ultraviolet radiation is the only possible "cure" of the disease as the somewhat unfortunate title of this heading might indicate. There is a short comment under the heading "Production of Conjunctivitis by Ultraviolet" in which no mention is made of the effect on the cornea. It seems, however, to this reviewer that subjects such as this are outside of the author's field and might better have been omitted.

H. D. Bouman

Infrared Photography in Medicine. By Leo C. Massopust, Sr., Director, Department of Art and Photography, Marquette University School of Medicine, Milwaukee, Wisconsin. Fabrikoid. Price, $2.75. Pp. 52, with 31 illustrations. Charles C Thomas, Publisher, 301 East Lawrence Avenue, Springfield, Illinois, 1952.

This monograph is written by a photographer who is well versed in the subject. It begins with a brief introduction on the physical aspects of light; the author states that the extension into the infrared region by means of the infrared photographic emulsion reaches about 13,500 Å.

There are excellent chapters on the materials and methods used in the application of infrared photography. The type of camera, film, light filters, exposure, and processing of the film are very clearly explained. The application of infrared to gross specimens, photomicrography, and the superficial venous patterns is also explained.

The monograph is profusely illustrated.

H. Montague

Dizionario technico di radiologia (italiano—français—deutsch—english—español). By Professor Franco Fossati, member of the Technical Committee of the Società Italiana di Radiologia Medica (S.I.R.M.). Cloth. Pp. 489. Publicazione, A. Wassermann, Milano, Italy, 1952.

As the author states in the preface, this dictionary was prepared at the suggestion of Professor Felice Perussia, President of the Società Italiana di Radiologia Medica, with the purpose of assembling the most frequent technical terms used in the Italian radiological literature and coordinating them with the synonymous terms of the French, German, English, and Spanish languages.

The dictionary, which embraces more than 3,500 words, is divided into two parts. Part I gives an alphabetic arrangement of the Italian words, followed in each instance by the translation into the four languages in the aforementioned order. Part II contains four distinct dictionaries, French-Italian, German-Italian, English-Italian and Spanish-Italian respectively. In these dictionaries the Italian words are listed following the words of the other languages by using the most common terms. To facilitate reference to Part I, in case that a translation from one foreign language through the intermediary of the Italian into another foreign language is desired, the corresponding word under which it may be found in Part I is also given in parenthesis.

The dictionary is intended primarily for Italian radiologists. However, the convenient reference system permits its easy use for translations in any of the other four languages. The author compiled the material with meticulous care and is to be congratulated on the splendid task accomplished. The technical features of the dictionary are likewise excellent. This fine book undoubtedly will find its place on the bookshelf of many readers interested in international radiology who wish to quickly consult an authoritative source of fast-growing radiological vocabulary in the five languages.

T. Leucutia, M.D.

BOOKS RECEIVED

An Atlas of Skull Roentgenograms. By Bernard S. Epstein, M.D., Associate Radiologist, The Jewish Hospital of Brooklyn, Brooklyn, New York; and Leo M. Davidoff, M.D., Neurosurgeon to the Mount Sinai Hospital, New York City, and Director of Neurological Surgery, the Beth Israel Hospital, New York City. Cloth. Price, $15.00. Pp. 415, with 603 illustrations on 315 engravings. Lea & Febiger, Washington Square, Philadelphia, Pennsylvania, 1953.

Man's Back. By Theodore A. Willis, A.M., M.D., F.A.C.S., Formerly Head, Department of Orthopedic Surgery, St. Luke's Hospital; Consulting Orthopedic Surgeon, U.S.P.H.S. Hospital, Cleveland, Ohio. Cloth. Price, $9.50. Pp. 170, with 210 illustrations. Charles C Thomas, Publisher, 301 East Lawrence Avenue, Springfield, Illinois, 1953.

Slipped Capital Femoral Epiphysis. By Armin Klein, M.D., Robert J. Joplin, M.D., John A. Reidy, M.D., and Joseph Hanelin, M.D., Massachusetts General Hospital, Boston, Massachusetts. Cloth. Price, $6.75. Pp. 144, with 230 illustrations. Charles C Thomas, Publisher, 301 East Lawrence Avenue, Springfield, Illinois, 1953.

Sectional Radiography of the Chest. By Irving J. Kane, M.D., Consultant in Chest Diseases, United States Naval Hospital, St. Albans, N. Y.; Attending Physician, Chest Diseases, Lincoln Hospital, New York, N. Y.; Associate Physician, Diagnostic Roentgenology, Montefiore Hospital, New York, N. Y. Cloth. Price, $7.50. Pp. 154, with 101 illustrations. Springer Publishing Company, Inc., 44 East 23rd Street, New York 10, New York, 1953.

I nuovi mezzi d'indagine nello studio radiologico del medisatino—Stratigrafia. By Pietro Amisano. Vol. I: 2ª Relazione, ATTI del XVII Congresso Nazionale di Radiologia Medica. Paper. Pp. 106, with 79 illustrations. Istituto per la Diffusione di Opere Scientifiche, Milano, 1952.

Le Gastriti (Studio Radiologico). By Giovanni Gardella, and Giovanni Sanquirico. Paper. Pp. 113, with numerous illustrations. Licinio Cappelli Editore, Bologna, 1952.

Gastriti. By Lorenzo Felci. Vol. I: 1ª Relazione, ATTI del XVII Congresso Nazionale di Radiologia Medica. Paper. Pp. 226, with 244 illustrations. Istituto per la Diffusione di Opere Scientifiche, Milano. 1952.

Radiologie du Rein et de l'Uretère. Par R. Gouverneur, Chirurgien de l'Hôpital Necker, Chef du service d'Urologie; P. Porcher, Radiologiste de l'Hôpital Saint-Antoine; and R. Hickel, Radiologiste du service d'Urologie de l'Hôpital Necker. Paper. Price, 5.400 fr. Pp. 440, with 421 illustrations. Masson & Cie, Editeurs, 120, Boulevard Saint-Germain, Paris (VIe), France, 1953.

A Collection of Urogenital Drawings. By William P. Didusch. Pp. 222, with 243 figures and legends, some in color. American Cystoscope Makers, Inc., 1241 Lafayette Avenue, New York 59, New York, 1952.

Contact Dermatitis. By George L. Waldbott, M.D., F.A.A.A., F.A.C.A., F.I.A.A., F.A.C.P., Senior Physician, Harper Hospital; Chief of Division of Allergy, Assistant Physician, Grace Hospital; Chief of Allergy Clinic, Formerly,

Director of Allergy Clinic, Children's Hospital of Michigan; Formerly, Consultant Allergist, St. Mary's Hospital and North End Clinic, Detroit, Michigan. Cloth. Price, $8.75. Pp. 232, with 332 illustrations. Charles C Thomas, Publisher, 301 East Lawrence Avenue, Springfield, Illinois, 1953.

Gastric Cancer. By Alfred H. Iason, M.D., Attending Surgeon, Adelphi Hospital; Director of Surgery, Brooklyn Hospital for the Aged; Surgeon, Manhattan General Hospital; Instructor in Anatomy, New York Medical College and Flower Hospital. Illustrations by Alfred Feinberg, Instructor of Medical Illustration, Department of Pathology, College of Physicians and Surgeons, Columbia University, New York, New York. Cloth. Price, $7.50. Pp. 316, with 98 illustrations. Grune & Stratton, Inc., 381 Fourth Avenue, New York 16, New York, 1953.

Fundamentals of Clinical Cancer. By Leonard B. Goldman, M.D., Clinical Professor of Radiotherapy, New York Medical College, Flower and Fifth Avenue Hospitals; Chairman, Tumor Conference and Director, Radiation Therapy Department, Queens General Hospital; Consultant Radiation Therapist, Flushing, Rockaway Beach and Triboro Hospitals, New York City. Cloth. Price, $8.75. Pp. 312, with 221 illustrations. Grune & Stratton, Inc., 381 Fourth Avenue, New York 16, New York, 1953.

Cancer, Problemas Clinico-Terapeuticos. By Manuel Riveros, M.D., Professor of Surgical Clinics, School of Medicine of Asuncion, Paraguay; with the collaboration of twenty other authors. Cloth. Pp. 534, with 535 illustrations. Paz Montalvo, Madrid, 1953.

Advances in Cancer Research. Volume I. Edited by Jesse P. Greenstein, National Cancer Institute, U. S. Public Health Service, Bethesda, Maryland; and Alexander Haddow, Chester Beatty Research Institute, Royal Cancer Hospital, London, England. Cloth. Price, $12.00. Pp. 590. Academic Press Inc., Publishers, 125 East 23rd Street, New York 10, New York, 1953.

A Handbook of Radiotherapy. By Walter M. Levitt, M.D., F.R.C.P. (Lond.), F.F.R., D.M.R.E. (Camb.) of Lincoln's Inn, Barrister-at-Law. Associate Physician to the Department of Radiotherapy, St. Bartholomew's Hospital, London; late Physician in Charge, Department of Radiotherapy, St. George's Hospital; late Examiner in Radiotherapy for the Fellowship, Faculty of Radiologists; and Lecturer in Radiotherapy for the D.M.R.E., Cambridge. Cloth. Price, $6.50. Pp. 232, with illustrations. Paul B. Hoeber, Inc., 49 East 33rd Street, New York 16, New York, 1953.

Die Nahbestrahlung. Von Henri Chaoul, Früher o. ö. Professor für Röntgenologie an der Universität Berlin; und Felix Wachsmann, Dozent für medizinische Physik an der Universität Erlangen. Cloth. Price, DM 39. Pp. 225, with 304 illustrations. Georg Thieme Verlag, Stuttgart, 1953.

Roentgen, Radium and Radioisotope Therapy. By A. J. Delario, M.D., Member of the American College of Radiology; American Board of Radiology; Radiological Society of North America; Head of Therapeutic Radiology, St. Joseph Hospital, Paterson, New Jersey. Cloth. Price, $7.50. Pp. 371, with 65 illustrations and 155 tables. Lea & Febiger, Washington Square, Philadelphia 6, Pennsylvania, 1953.

Radioisotopía Clínica. By F. Manchón, A. Modolell, A. Miguel, A. Subias, and J. Farrerons. Cloth. Pp. 283, with 47 illustrations. Publicaciones médicas, José Janés, Editor, Muntaner, 316, Barcelona, Spain, 1951.

Dizionario tecnico di radiologia (italiano—français—deutsch—english—español). By Professor Franco Fossati, member of the Technical Committee of the Società Italiana di Radiologia Medica (S.I.R.M.). Cloth. Pp. 489. Publicazione, A. Wassermann, Milano, Italy, 1952.

Radiation Chemistry. Discussions of the Faraday Society. No. 12, 1952, Cloth. Pp. 319. The Aberdeen University Press Ltd., 6 Upper Kirkgate, Aberdeen, 1952.

Physics and Medicine of the Upper Atmosphere. A Study of the Aeropause. Editors: Clayton S. White, M.D., Director of Research, Lovelace Foundation for Medical Education and Research; Head of a Section of Aviation Medicine, Lovelace Clinic; and Otis O. Benson, Jr., Brigadier General, USAF (MC); Commandant, USAF School of Aviation Medicine. The Proceedings of a Symposium on the Physics and Medicine of the Upper Atmosphere held at San Antonio, Texas, November 6, 7, 8, 9, 1951, sponsored by The Air University School of Aviation Medicine, Randolph Field, Texas. Arranged by The Lovelace Foundation for Medical Education and Research, Albuquerque, New Mexico. Cloth. Price, $10.00. Pp. 611, with 150 illustrations and 46 plates. University of New Mexico Press, Albuquerque, New Mexico, 1952.

The Physician in Atomic Defense. By Thad P. Sears, M.D., F.A.C.P., Associate Clinical Professor of Medicine, University of Colorado School of Medicine; Chief of Medical Service, Veterans Administration Hospital, Denver; Member of Advisory Staff to Director of Civil Defense, State of Colorado; Member of Disaster Commission, Colorado State Medical Society; Colonel (M.C.), U.S.A.R. Cloth. Price, $6.00. Pp. 308, with illus-

trations. Year Book Publishers, Inc., 200 E. Illinois Street, Chicago 11, Illinois, 1953.

Experimental Nuclear Physics. Volume I. Edited by E. Segrè. Cloth. Price, $15.00. Pp. 789. John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, New York, 1953.

Pharmacology and Toxicology of Uranium Compounds. Parts III and IV. Edited by Carol Voegtlin, Ph.D., Lecturer in Cancer Research and Toxicology, School of Medicine and Dentistry, University of Rochester; formerly Chief of the Division of Pharmacology, National Institute of Health, U. S. Public Health Service; formerly Director of Cancer Research and Chief of the National Cancer Institute; and Harold C. Hodge, Ph.D., Professor of Pharmacology and Toxicology, School of Medicine and Dentistry, University of Rochester. Cloth. Price, $18.00. Pp. 1087–2466, with illustrations. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 36, New York, 1953.

Annual Review of Medicine. Volume 4. By Windsor C. Cutting, Editor, Stanford University School of Medicine; and Henry W. Newman, Associate Editor, Stanford University School of Medicine. Cloth. Price, $6.00. Pp. 452. Annual Reviews, Inc., Stanford, California, 1953.

Building America's Health. America's Health Status, Needs and Resources—Volume 2. By The President's Commission on the Health Needs of the Nation. Paper. Price, $1.25. Pp. 320. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., 1953.

Building America's Health. America's Health Status, Needs and Resources—A Statistical Appendix—Volume 3. By The President's Commission on the Health Needs of the Nation. Paper. Price, $1.50. Pp. 299. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., 1953.

Vol. 72, No. 2

ABSTRACTS OF RADIOLOGICAL LITERATURE

Department Editor: T. Leucutia, M.D., Harper Hospital, Detroit 1, Michigan

INDEX TO ABSTRACTS

ROENTGEN DIAGNOSIS

Pfeiffer, K., and Seige, K.: Differential diagnosis of salivary calculi and phleboliths in the region of the cheek 334

Head

Bull, J. W. D.: The radiological differential diagnosis of lesions of the posterior fossa 334

Neck and Chest

Vergoz, Tillier, and Laquière: The clinical application of mastography 335

Gordon, J., Zinn, W. B., and Brook, R.: Pulmonary distention as seen in the lordotic roentgenogram 335

Donald, I., and Steiner, R. E.: Radiography in the diagnosis of hyaline membrane 336

Schecter, M. M.: Diffuse interstitial fibrosis of the lungs 336

Silverstein, C. M.: Pulmonary manifestations of leptospirosis 336

Boucher, H., Sautter, V., and Thiébault, J.: Recent data on ornithosis; with reference to 34 cases collected from the Army 336

Lane, N., Murray, Margaret R., and Fraser, G. C.: Neurilemoma of the lung confirmed by tissue culture; report of a case. 337

Abrams, H. L., Hencky, G., and Kaplan, H. S.: The use of delayed films in bronchography 337

Simon, G., and Galbraith, H.-J. B.: Radiology of chronic bronchitis 338

Storey, C. F., Knudtson, K. P., and Lawrence, B. J.: Bronchiolar ("alveolar cell") carcinoma of the lung 338

Abdomen

Donnelly, B.: Gastro-oesophageal regurgitation and oesophageal hiatus hernia; with special reference to the differential diagnosis of angina pectoris. (The Barclay prize essay, 1953.) 338

Albot, G., *et al.*: Front and side-view cholecystography, with a study of the angle of vesicular erection, of the volume of the gall-bladder and of the volumetric coefficient of evacuation 339

Nemours-Auguste, and Barag, N.: Intravenous cholangiocholecystography; opacification of the intra- and extrahepatic ducts with a new substance 339

Keil, P. G., Hegstrom, G. J., and Zoeckler, S. J.: Cholangiography 340

Martins, J. D.: Operative cholangiography; experience with 120 cases 340

Moyson, Fr.: Toxic hepatitis after cholangiography 340

Berenbaum, M. C., and Birch, C. A.: Thorium deposits in the liver; demonstrated during life 340

Muntean, E.: Further results of the roentgen digestion test 340

Freye, K.: Progress in the roentgen examination of the stomach by means of magnification and high voltage technique 341

Almy, M. A., Volk, F. H., and Graney, C. M.: Situs inversus of stomach 341

Abbot, F., and Blank, S.: Gastric ulcer—benign or malignant; preliminary report of a roentgenologic study 341

Cimmino, C. V.: Roentgenographically characteristic adenocarcinoma and leiomyosarcoma in the same stomach 341

Gross, K. E., and Durham, M. W.: Pyloric antral mucosal diaphragm; report of a case .. 342

Fox, P. F.: Duodenal obstruction in infants and children 342

Wisoff, C. P.: Jejunogastric intussusception .. 342

Cregg, H. A., and Smith, F. G.: Radiographic demonstration of localized mesenteric thrombosis; a case report 343

Kunstader, R. H., Guterman, H. S., and Tulsky, A. S.: Transabdominal pneumoperitoneum as an aid in the diagnosis of sex-endocrine disturbances 343

Olivier, Cl., Arvay, N., and Ferrari, J.: Roentgen diagnosis of small intestinal obstruction due to bands and adhesions 343

Heuck, F.: Small intestinal changes in ascariasis as an expression of enteral allergy 343

Singleton, A. C.: Some radiological aspects of cancer of the colon. The Richards Lecture. Part I. Part II 343

Gynecology and Obstetrics

Cook, D. G., and Butt, J. A.: Hysterosalpingography studies following ectopic pregnancy 344

Crick, A. F., and Sims, F. H.: Gas within the foetus indicating foetal death..... 344
Riva, H. L., Andreson, P. S., and O'Grady, J. W.: Pregnancy and Hodgkin's disease; report of eight cases..... 344

Genitourinary System

Camerini, R., Zaffagnini, V., and Lolli, G.: Tomography as a research means of bladder walls..... 345
Stewart, C. M.: Delayed cystograms..... 345
Bunge, R. G.: Delayed cystograms in children..... 345
Roberts, H.: Observations on micturition in the female..... 345
Hodgkinson, C. P., and Doub, H. P.: Roentgen study of urethrovesical relationships in female urinary stress incontinence..... 346
Pyrah, L. N., and Smiddy, F. G.: Pararenal pseudo-hydronephrosis: a report of two cases..... 346
Faingold, J. E., Hansen, C. O., and Rigler, L. G.: Cystitis emphysematosa; review of the literature and report of four cases diagnosed by roentgen examination..... 346

Skeletal System

Veller, K., and Laur, A.: Etiology of infantile cortical hyperostosis (Caffey's syndrome)..... 347
Schröder, W.: Adolescent spongiosclerosis... 347
Ingram, A. J., and Bachynski, B.: Fractures of the hip in children; treatment and results. 348
Platou, E.: Luxatio coxae congenita; a follow-up study of four hundred and six cases of closed reduction..... 348
Bloom, J.: Osteitis condensans ilii..... 349
Dahlin, D. C., Wells, A. H., and Henderson, E. D.: Chondromyxoid fibroma of bone; report of two cases..... 349
Compere, E. L.: The diagnosis and treatment of giant-cell tumors of bone..... 349
Ivins, J. C., and Dahlin, D. C.: Reticulum-cell sarcoma of bone..... 350
Curtis, R. M.: Congenital arteriovenous fistulae of the hand..... 350
Carroll, R. E.: Osteoid osteoma in the hand. 351
Reich, R. S., and Rosenberg, N. J.: Aseptic necrosis of bone in Caucasians with chronic hemolytic anaemia due to combined sickling and thalassemia traits..... 351
Ronald, J.: Aseptic necrosis of bone in caisson disease..... 352
Cohen, J., Brown, K. A., and Grice, D. S.: Ewing's tumor of the talus (astragalus) simulating aseptic necrosis..... 352
Jacobson, G., and Adler, D. C.: An evaluation of lateral atlanto-axial displacement in injuries of the cervical spine..... 353
Stewart, T. D.: The age incidence of neural-arch defects in Alaskan natives, considered from the standpoint of etiology..... 353
Holland, H. W.: Tabetic spinal arthropathy. 354
Lippmann, R. K.: Arthropathy due to adjacent inflammation..... 354

Blood and Lymph System

Gvozdanović, V., and Oberhofer, B.: Mediastinal phlebography; a bilateral simultaneous injection technique..... 355
Horton, R. E., and Nanson, E. M.: Technique and value of aortography; report of a case of external iliac arterial graft..... 355
Ivy, R. E., and Howard, F. H.: Sickle-cell anemia with unusual bone changes..... 356
Shefts, L. M., Terrill, A. A., and Swindell, H.: Scalene node biopsy..... 356

General

Latham, W. J.: Hydatid disease. Part II. Hydatid disease in the renal tract, bone, muscles, and nervous system..... 356
Turner, J. W.: Observations on neoplastic spread; some radiologic aspects of the problem..... 357
Grossiord, A., Bernard, J., and Marteau, R.: Myopathy and sequelae of poliomyelitis; role of muscle roentgenography..... 358
Harrison, Mary T., and Mercer, R. D.: Vitamin A intoxication..... 358

RADIATION THERAPY

McCormick, N. A.: A report on the survival of the patients treated for cancer from 1935 to 1947 inclusive..... 358
Brown, W. M. C., and Mahler, R. F.: The x-ray dose-body size relationship in radiation sickness..... 358
Krabbenhoft, K. L., and Leucutia, T.: Subdeltoid bursitis..... 359
Finzi, N. S.: A new method of treatment for arthritis..... 359
Lederman, M.: Radiotherapy of cancer of the penis..... 360
Brintnall, E. S.: Surgical treatment of post-irradiation rectal stricture and rectovaginal fistula..... 360
Dobbie, B. M. W.: Vaginal recurrences in carcinoma of the body of the uterus and their prevention by radium therapy..... 361

RADIOISOTOPES

Neumayr, A., Brichta, G., and Vetter, H.: On the measurement of peripheral blood circulation by determination of the tissue clearance with radioactive iodine..... 361
Rugh, R.: Thiouracil modification of effect of radioiodine (I^{131}) on the thyroid..... 361
Lang, N., and Nöller, H.-G.: Relationships

of excretion rates of radioiodine in normals and hyperthyroids..... 362
Blanco Soler, C., Salgado Alba, A., and Blanco Soler y Ros, C.: Considerations on 40 cases of hyperthyroidism treated with radioactive iodine..... 362
Neil, R. H., Costolow, W. E., and Meland, O. N.: Design and construction of a simple applicator for 1,000 curies of cobalt 60..... 362
Batley, F.: Cobalt^{60} teletherapy; some principles and observations..... 363

MISCELLANEOUS

Gund, K., and Berger, H.: The 15 mev. betatron for medical application built by the Siemens-Reiniger-Werke..... 363
Gund, K., and Schittenhelm, R.: The physical properties of the radiation beams of the 15 mev. betatron of Siemens-Reiniger-Werke. 363
Dittrich, Wolfgang, and Schubert, Gerhard: The mechanism of action of fast electrons in biologic objects..... 364
Gärtner, H., and Peters, K.: The effect of the dose and dose rate of roentgen rays and fast electrons on the frequency of mitosis in tissue cultures..... 364
Bode, H.-G., Hampel, D., and Markus, B.: Further experiences in the irradiation of growths with fast electrons..... 365
Nödl, F.: On tissue changes of human skin following the action of fast electrons..... 365
Kepp, R. K.: Interdependence of ionization density and effect of time factor..... 365
Markus, B., and Paul, W.: On dose measurement and dose distributions in electron-irradiated materials..... 366
Markus, B., and Paul, W.: Photographic dosimetry in electron-irradiated materials.... 366
Markus, B., and Paul, W.: A body cavity cone for electron irradiations with the betatron..... 366

ROENTGEN DIAGNOSIS

Head

Pfeiffer, Klaus, and Seige, Konrad. Zur Differentialdiagnose der Speichelsteine und Phlebolithen im Wangenbereich. (Differential diagnosis of salivary calculi and phleboliths in the region of the cheek.) *Radiol. clin.*, Sept., 1953, *22*, 445–461.

The authors observed an unusual case of a boy, eighteen years of age, who had a fist-sized swelling of the right parotid region due to an intramural hemangioma cavernosum of the cheek containing numerous phleboliths. They made a detailed chemical analysis of the saliva collected from the parotid glands of the two sides, took numerous roentgenograms in various projections and performed sialography. Then they compared the data so obtained with those formerly secured in cases of salivary calculi. Finally, they studied the roentgen shadows cast by the phleboliths and salivary calculi by roentgenographing phleboliths removed from an extensive hemangioma of the lower extremity of another patient and comparing these with roentgenograms of available salivary calculi.

The authors summarize the results of their investigations in Table I.

An accurate differentiation of phleboliths found in association with cavernous hemangiomas of the parotid region from salivary calculi of the parotid gland proper is desirable since the therapeutic approach in the two instances varies considerably. The authors cite briefly a case of hemangioma in the said region which was successfully treated by interstitial radium puncture.—*T. Leucutia, M.D.*

Bull, J. W. D. The radiological differential diagnosis of lesions of the posterior fossa. *Proc. Roy. Soc. Med.*, Sept., 1953, *46*, 729–736.

The author believes that in nearly all cases of posterior fossa tumors by the time clinical symptoms develop the presence of a lesion can be demonstrated roentgenologically. While the position of the tumor can be stated fairly accurately, the size, shape and

Table I

DIFFERENTIAL DIAGNOSIS OF PHLEBOLITHS AND SALIVARY CALCULI

	Hemangioma Phleboliths	Salivary Calculi
sex	65% incidence in female	75% incidence in male
age	between 1 and 30 years	between 20 and 60 years
occurrence	most frequently in cavernous hemangiomas of the extremities, in muscular hemangiomas and rarely in hemangiomas of the head	in all salivary glands: submaxillary glands, 75 to 82%; parotid glands, 13 to 20%; and sublingual glands, 5%.
localization	in dilated veins	in the intraglandular and extraglandular salivary ducts
shape	rounded to elliptical or dumbbell shaped	rounded, elliptical, cylindrical, barrel-shaped, tube-shaped
size	millet seed to bean size	millet seed to egg size
surface	predominantly flat	predominantly coarse to granular
color	white	gray-white to yellowish
weight	under 20 grams	in Stensen's duct maximum of 18.6 grams, in the submaxillary gland maximum of 236 grams
chemical composition	calcium carbonate, calcium phosphate, tissue detritus	calcium carbonate, calcium phosphate, tissue detritus, ptyalin, rarely cholesterin
origin	calcification of thrombi along the blood vessel walls	calcification around foreign bodies and inflammatory mucous plugs
clinical significance	differentiation of deep-seated hemangiomas	possible cause of symptoms and late sequelae
symptoms	no pain, evidence of hemangioma	(a) without symptoms; (b) with symptoms: possible cramps, fistula formation, inflammation, "tumor"
roentgen appearance	shell-like calcification, rosette formation, often central translucency, usually multiple shadows	most frequently homogeneous, rarely central translucency, quite often increased central density and layer formation, usually single shadow; sialography is very important

pathological nature cannot be determined in many cases. Plain roentgenography, laminagraphy, angiography, pneumoventriculography, pneumoencephalography and contrast ventriculography are the available methods of neuro-roentgenologic examination.

Vertebral angiography initially was considered hopefully as a method for indicating the size and shape of tumors. Radner's monograph on 221 vertebral angiographies, which included 40 posterior fossa tumors, showed, however, that angiography was less reliable than ventriculography as in only 8 cases was the tumor outlined by its vessels.

While plain roentgenograms of the skull may be disappointing they should never be omitted. They may show signs of pressure by sellar decalcification and later by erosion by a lesion anywhere in the brain. Very rarely unilateral thinning and bulging of the infratentorial portion of the squamous occipital bone may be seen in tumors of one cerebellar hemisphere.

Calcification in posterior fossa tumors is very rare. Dermoids growing from the region of the torcular may cause a furrow in the bone. Plain roentgenograms are especially valuable in the differential diagnosis of acoustic neuromas, which comprise about one-third of all posterior fossa tumors. In a series of 50 confirmed acoustic neuromas, in 76 per cent the internal auditory meatus was widened. Roentgenograms in multiple views of this region should always be made.

Laminagraphy has not been of great value in demonstrating posterior fossa lesions except in indicating basilar impression more clearly.

The author does not agree with the statement that hydrocephalus is necessary for the diagnosis of posterior fossa tumors. In his series of 50 cases of acoustic tumors hydrocephalus was present in only 27. With absence of hydrocephalus and of changes in the meatus the only sign may be rotation of the fourth ventricle.

The aqueduct and fourth ventricle are very sensitive structures and are displaced by nearly all posterior fossa tumors. Tumors of the hemispheres kink the aqueduct forward and displace it and the fourth ventricle laterally. Superior vermis tumors kink the aqueduct forward, but do not displace it or the fourth ventricle laterally.

The author believes that posterior fossa tumors very rarely obstruct the aqueduct.

The mid-brain must always be considered as well as the posterior fossa in all tumors showing hydrocephalus at ventriculography. Hydrocephalus can be caused by space-occupying lesions situated anywhere from the foramina of Monro backwards and downwards.

When ventriculography demonstrates a mass in the region of the pineal gland a differential diagnosis between tumor and arachnoid cyst should be considered.

In general, ventriculography is reliable in localizing posterior fossa tumors. Myodil ventriculography may be indicated subsequently if the third ventricle is not dilated.—*J. N. Ané, M.D.*

Neck and Chest

Vergoz; Tillier; and Laquière. La mastographie au service de la clinique. (The clinical application of mastography.) *Presse méd.*, Oct. 21, 1953, *61*, 1347–1349.

Roentgenography of the breast has confirmed the clinical impression in the great majority of cases and has been consistent with the pathological findings. Malignant tumors appear irregular, lobulated, fuzzy-outlined with several small scattered specks. In general, the mass roentgenographically is smaller than it appears on palpation. However, the roentgen findings do not establish the diagnosis, they merely confirm a clinical impression.—*M. L. Sussman, M.D.*

Gordon, Joseph, Zinn, W. Berkeley, and Brook, Ray. Pulmonary distention as seen in the lordotic roentgenogram. *J. Thoracic Surg.*, Sept., 1953, *26*, 261–274.

It is considered that an anterior mediastinal lung hernia exists only when the anterior portion of one lung extends beyond the trachea into the opposite hemithorax. When all of the mediastinal structures are displaced, the situation is obvious. However, when the readily visible mediastinal structures lie in normal position or are only slightly displaced, it may not be apparent from the usual posteroanterior chest roentgenogram that a sizable anterior mediastinal lung hernia exists. In the latter situation, the lung hernia is demonstrated best, or only, in a lordotic roentgenogram.

Contralateral pulmonary distention results from loss of lung volume secondary to pulmonary disease, resection of lung tissue or limitation of expansion by pleurogenic factors. In the cases studied, it was noted that contralateral pulmonary distention may persist after thoracoplasty. There were cases that had contralateral tuberculous foci with herniation of the lung before thoracoplasty was done, and at a later date it was noted that the hernia persisted and the contralateral lesion broke down. While a correlation between pulmonary overdistention and breakdown of tuberculous foci was suggested, more evidence for this relationship is needed.

The lordotic roentgenogram is also valuable as a guide in assessing re-expansion of the lung following pneumothorax or resection and it is used to indicate when a thoracoplasty might be added to advantage. If, after pulmonary resection, decortication or pneumothorax, contralateral pulmonary expansion develops or exceeds the pre-existing change, a thoracoplasty is generally done since the finding is

probably evidence that the expansion of the remaining ipsilateral lung is limited.—*Paul C. Olfelt, M.D.*

Donald, Ian, and Steiner, R. E. Radiography in the diagnosis of hyaline membrane. *Lancet*, Oct. 24, 1953, *2*, 846–849.

The authors discuss the roentgenologic findings in hyaline membrane of the lungs in the newborn.

These findings are: (1) A fine miliary mottling throughout the lung fields, followed by (2) coarser and more coalescent type of opacity, although the bronchial tree is often clearly demonstrated, and finally by (3) confluent dense shadows as a result of lobar or lobular consolidation and collapse.

Abstracts are given of the case histories of 28 newborns with respiratory distress and showing abnormal roentgenologic findings. These cases are divided into five groups:

I. Significant roentgenologic signs and hyaline membrane found at necropsy. (11 cases)

II. Clinical signs of atelectasis, but no roentgenologic signs, and hyaline membrane not found at necropsy. (8 cases)

III. No roentgenologic signs but hyaline membrane found at necropsy. (0 cases)

IV. Roentgenologic and clinical signs present, but child recovered; diagnosis, therefore, unproved. (4 cases)

V. Roentgenologic signs present, but lesions other than hyaline membrane found at necropsy. (5 cases)

It is the opinion of the authors that the sequence of (1) miliary mottling, (2) coarse mottling, and (3) lobar consolidation and collapse is to be found only when hyaline membrane is present. They differ with Caffey who described a somewhat similar appearance, and ascribed it to structural immaturity of the alveolar buds.—*J. H. Harris, M.D.*

Schecter, M. Murray. Diffuse interstitial fibrosis of the lungs. *Am. Rev. Tuberc.*, Oct., 1953, *68*, 603–614.

Since 1933, 19 cases of diffuse interstitial fibrosis of the lungs have been reported, only 2 of which have been treated with corticotropin or cortisone. The disease is progressive to death and the etiology remains unknown.

The author reports 2 additional cases. The first is that of a thirty-one year old farmer who had had progressive symptoms of chest pain, cough and dyspnea for three months. He grew worse on various antibiotics and was premoribund when an intravenous drip of 25 mg. corticotropin daily was begun. After four days, he was dramatically improved, and after three weeks he was given 100 mg. cortisone daily as maintenance therapy. The roentgen changes of bilateral interstitial fibrosis cleared dramatically on this therapy and remained so. After two months the therapy was withdrawn over a ten day period; four days later his symptoms and roentgen changes recurred and he died shortly thereafter. The diagnosis was confirmed at necropsy.

The other case was that of a thirty-eight year old clerk who had had progressive symptoms for four years. He required oxygen therapy on the last admission. The roentgen changes were those of bilateral generalized interstitial fibrosis. This patient was given a thirty day course of intravenous corticotropin without subjective or roentgenological improvement and his course was retrogressive to chronic asphyxiation. The diagnosis was confirmed at necropsy.

The conclusion drawn from these 2 cases is that the use of corticotropin may be life-saving in the acute type of disease, but maintenance on cortisone should be continued indefinitely. In the chronic type in which fibrosis has been present for some time, the steroids would seem to be of little help.—*Paul E. Mink, M.D.*

Silverstein, Charles M. Pulmonary manifestations of leptospirosis. *Radiology*, Sept., 1953, *61*, 327–334.

"Leptospirosis" is the disease produced by any of the group of spirochetes known as Leptospira. There have been about 30 pathologic strains of these organisms identified throughout the world but only 4 have been recognized in the United States. Leptospirosis occurs with sufficient frequency in this country that it should be considered in the differential diagnosis of any acute febrile illness accompanied by one or more of the following features: jaundice, nephritis, aseptic meningitis, hemorrhagic pneumonitis. *Lept. icterohaemorrhagiae* produces the most common, distinctive, and virulent type of leptospiral infection, the acute febrile illness known as "Weil's disease." Pulmonary involvement is occasionally an early or most striking clinical manifestation.

The author reviewed the case histories and roentgenograms of 33 patients with leptospirosis. In 2 cases the roentgen changes consisted of localized or segmental "bronchopneumonia." Two patients had widely disseminated small pulmonary infiltrations. In 1 case there was a massive area of consolidation. Postmortem examination in 2 cases demonstrated that the roentgenographic findings, which were interpreted as "pneumonia," were due to pulmonary hemorrhage and edema.—*Arno W. Sommer, M.D.*

Boucher, H., Sautter, V., and Thiébault, J. Données nouvelles sur l'ornithose; à propos de trente-quatre observations recueillies dans l'armée. (Recent data on ornithosis; with reference to 34 cases collected from the Army.) *Presse méd.*, Oct. 1, 1953, *61*, 1236–1238.

Ornithosis, a psittacosis-like disease, appears mostly under the disguise of a mild pulmonary infection, but all degrees exist from severe pneumonia to minimal lesions discovered occasionally in survey photofluorographic examinations of the chest. Clini-

cally, it starts with a short period of malaise followed by a long-standing troublesome cough. Occasionally, as in virus pneumonia, hemoptysis is present, and more seldom albuminuria and disturbance of the pulse-temperature ratio is noted. The cough is dry and disagreeable, and with secondary infection it becomes mucopurulent. The temperature is usually around 102.2° to 104° F. for many days, but one may encounter afebrile cases. On auscultation, bullous rales are present which persist in the axillae and are typical of the disease. Another sign which never appears in virus pneumonia is the occasional presence of peripheral adenopathy. The course of the disease is mostly benign in the young. Toxic forms appear in old persons and in the debilitated. Convalescence is of long duration.

Roentgenologically, ornithosis may simulate a virus infection with segmental distribution (16 cases), or middle lobe selection (4 cases). More often, however, it shows hilar adenopathy with extensive infiltration which may be mistaken for a primary tuberculous infection.

The authors recommend many biological laboratory tests, some for their negative values. Those classified under orientation tests are: the lymphomononucleosis, the cold agglutinine, transitory positive syphilitic serology, and of the less well known: the strepto M. G. agglutinine, the agglutinine T and the anti-Gallus agglutinine. Among the tests classified as certain the most important is the deviation of the positive complement with an antigene of the group ornitho-psittaco-lymphogranulomatosis venereum.

Bronchoscopically, one sees in the early cases signs of a localized bronchial infection; in the later cases no anomalies are manifested. Aureomycin and terramycin have been found to be the remedies of choice; 10 g. of either one is sufficient in doses of 1 g. per day for adults and 0.5 g. for children. Penicillin had no effect on the disease, but may have improved a superimposed mixed infection.

The authors made biological tests, starting January, 1950, on 262 patients suffering from acute pulmonary nontuberculous disease and found 34 cases definitely positive to complement deviation with the ornithosis-psittacosis antigen—a rate of 12.97 per cent. About half of the cases discovered (17 cases) were attributed to contamination, in an endemo-epidemic fashion, of patients living close to chicken and pigeon farms, or having contact with carrier pigeons in an Army camp. The other half of the patients (17 cases) had no apparent contact with fowl and were classified as cases sporadically contaminated by the accidental inhalation of virus dust. An additional 20 sporadic cases were isolated since this work was sent for publication.

The authors conclude by stating that the disease is apparently more prevalent in France than it was suspected and merits the attention of physicians and hygienists.—*S. Silvera, M.D.*

Lane, Nathan, Murray, Margaret R., and Fraser, Glendon C. Neurilemoma of the lung confirmed by tissue culture; report of a case. *Cancer*, July, 1953, *6*, 780–785.

The term neurilemmoma is defined, and apparently gets its origin from Stout. The cell from which the tumor arises is believed to be the nerve sheath cell of Schwann. Other names which are given these tumors are briefly discussed.

The frequent occurrence of neurogenic tumors in the posterior mediastinum is noted to stand out in very sharp contrast to their rarity within the pulmonary parenchyma, there being only 3 cases recorded in the literature of solitary intrapulmonary neurogenic tumors. The authors point out that on review of the slides of these 3 cases it was found that all lacked the typical histopathological features of neurilemmoma and were classified as either "neurogenic tumor" or "neurofibroma."

The tumor reported here combines the three features of being entirely within the pulmonary parenchyma, of being typical histopathologically of neurilemmoma, and of being confirmed as such by tissue culture.

The patient was a sixteen year old school girl, who was admitted following the discovery of an area of increased density in the right upper lung field, noted on a routine chest survey made several months before. During the first six years of life the patient was frequently exposed to the mother who died of pulmonary tuberculosis: however, repeated Mantoux tests were negative until 1941, when a positive reaction was obtained. The patient had remained in good health during the interim of some several years.

Roentgen examination of the chest revealed a solitary oval density measuring 3.5 by 2.5 cm. at the level of the anterior part of the second right rib in the medial portion of the posterior segment of the right upper lobe. This mass was entirely removed at surgery and the pathological diagnosis made. Also, a total of 25 implants were made from the tumor specimen and the outgrowth was typical of neurilemmoma.—*Robert D. Moreton, M.D.*

Abrams, Herbert L., Hencky, Gerhard, and Kaplan, Henry S. The use of delayed films in bronchography. *Radiology*, Sept., 1953, *61*, 317–326.

Bronchograms are at times unsatisfactory because (a) inability to control the cough reflex results in spread of the opaque material into the alveoli and (b) there is incomplete opacification of some of the major or segmental bronchi. The first factor may be controlled by careful topical anesthesia. The effect of the second factor may be partially eliminated by the use of films obtained one-half hour after the initial examination.

The authors investigated the value of delayed films

in bronchography. One hundred consecutive bronchographic studies were performed on 75 patients. Delayed films were obtained from thirty to sixty minutes after the initial bronchograms. In 36 of these examinations, delayed films were of definite value. In 10 cases, delayed films established the presence of bronchiectasis not demonstrated in the original examination.

Delayed films were found to be particularly valuable in exploration of the middle lobe, the lower lobes and the lingula, and should be obtained whenever the bronchi to these lobes are inadequately demonstrated.—*Arno W. Sommer, M.D.*

Simon, George, and Galbraith, H.-J. B. Radiology of chronic bronchitis. *Lancet*, Oct. 24, 1953, *2*, 850–852.

In a study of 857 patients with chronic bronchitis, posteroanterior roentgenograms were made, and it was found that there is a correlation between the clinical severity of the bronchitis and the roentgen findings of emphysema. The criteria used to make a diagnosis of emphysema were a low flat diaphragm, a narrow vertical heart with prominence of the pulmonary artery, an abnormal pulmonary vascular pattern, and evidence of bullae. At least three of the four signs had to be present to establish the roentgenologic diagnosis.

Bronchograms were made on 90 of the above patients, and 79 per cent of these showed abnormality. The abnormalities were excessive variation of the bronchial caliber on respiration, localized beading, bronchial diverticulosis, peripheral pooling, and poor filling of the smaller bronchi and bronchioles.—*F. B. Markunas, M.D*

Storey, Clifford F., Knudtson, Kenneth P., and Lawrence, Benjamin J. Bronchiolar ("alveolar cell") carcinoma of the lung. *J. Thoracic Surg.*, Oct., 1953, *26*, 331–406.

The authors reviewed the literature on the pulmonary neoplasm which has been known as alveolar cell carcinoma, bronchiolar carcinoma and pulmonary adenomatosis. Thirty-seven hitherto unrecorded cases of this tumor are reported. One hundred and eight cases which appeared in the literature previously and the 37 cases are statistically analyzed. The features of the disease are described.

It is estimated that this tumor constitutes between 1.5 and 5 per cent of all pulmonary carcinomas. In contrast with bronchogenic carcinoma, there is no strong sex predominance. In this group of cases there was almost an equal sex distribution. The youngest patient reported with bronchiolar carcinoma was a boy of sixteen years and the oldest a man of eighty-nine years. The average age was fifty-four years.

The precise site of origin of the tumor has not been definitely determined. It appears that it arises from the periphery of the lung but whether it is of alveolar or bronchiolar origin has not been established. While some think it is of multicentric origin, the authors indicate they believe it begins from a single focus from which it may spread by local extension, lymphatic channels, blood route or by bronchiogenic dissemination.

No distinctive clinical or roentgen features are present whereby the lesion may be recognized. Early symptoms are minimal or absent, and late complaints are those of widespread chronic pulmonary disease. There may be an excessive production of sputum. Roentgenologically, the lesions may vary from a single nodule to diffuse nodular disease. Occasionally, cavitation is present. Of the various diagnostic methods, the authors cite the cytological studies of the sputum as being the most rewarding.

The only hopeful treatment at present is surgery. Since the tumor has peculiar growth characteristics, conservative pulmonary resection is advocated. As yet there is not an adequate number of resected cases for a significant five year follow up study but at least 5 five year survivals have been reported. The authors suggest that with early resection, the cure rate in bronchiolar carcinoma may be better than in other lung cancer.—*Paul C. Olfelt, M.D.*

Abdomen

Donnelly, Brian. Gastro-oesophageal regurgitation and oesophageal hiatus hernia; with special reference to the differential diagnosis of angina pectoris. (The Barclay prize essay, 1953). *Brit. J. Radiol.*, Sept., 1953, *26*, 441–454.

The importance of hiatus hernia as a cause of substernal distress was not recognized until after the use of roentgen rays in the diagnosis of gastrointestinal tract disease became general, and furthermore, it was even later that the frequent occurrence of esophageal regurgitation was appreciated. The three types of hiatus hernia are now easily identified and classified. Occasionally a case presenting a typical history cannot be shown to have a hernia and this led to investigation of regurgitation and its evaluation.

There is no true sphincter at the cardiac end of the esophagus. The esophagus enters the stomach obliquely just below the hiatus in the diaphragm. The fibers of the diaphragm, when contracted around the esophagus, act as a sort of pinchcock, but a more important natural mechanism is the hiatal valve. The walls of the esophagus are held together by the intragastric pressure, the upper or left anterior lip of the cardiac orifice being pressed against the opposite wall of the esophagus. Normally this valve-like apparatus opens when the pressure in the esophagus rises above the intragastric pressure, as when a peristaltic wave reaches the lower end of the esophagus. During deep inspiration the pressure differential

between the stomach and the esophagus becomes greater, and the valve is mechanically less efficient because of change in the relationship between the lips of the cardiac orifice; but to offset these two factors, during deep inspiration the pinchcock action of the diaphragm is more important.

One of the common occurrences which puts a strain on the hiatal valve is the act of belching. When air is trapped in the lower esophagus rather than being completely expelled, it leads to more belching, originating a cycle. Frequent strain of this type on the hiatal valve may lead to incompetence. The posterior lip of the valve is supported by fibers of the left crus of the diaphragm, and any splitting of these fibers, either on a developmental basis, or because of frequent belching will lead to incompetence of the valve and then the pressure differential which kept the valve closed favors regurgitation. Under these conditions sliding of the gastric mucosa through the hiatus occurs, followed by true hiatus hernia.

A series of patients was examined with these factors in mind, and it was found that the detection of regurgitation was just as important as the demonstration of a hernia from the point of view of relating the roentgenological findings to the patient's symptoms. Fluid barium suspensions and abdominal compressors were used, and regurgitation was considered to be present if barium re-entered the esophagus when the patient was recumbent, after all the barium had left the esophagus following swallowing while upright. Somewhat higher intragastric pressures were necessary than could be produced by manual compression or stooping. It is pointed out that some of the factors which might prevent demonstration of regurgitation at one single examination are: (1) insufficient intragrastric pressure; (2) too large an amount of barium, decreasing gastric muscular tone; (3) variations in the tone of the stomach or the competence of the hiatal valve, which occur during the day because of belching or fasting.

When regurgitation becomes a common occurrence, the esophagus must assume the added load of returning the contents to the stomach. Barium is observed to regurgitate with the patient recumbent, but air regurgitated with the patient upright would have the same effect. Since sudden effort increases the intra-abdominal pressure, leading to regurgitation, some of these patients present themselves with symptoms of angina pectoris. It is suggested that all cases of angina of effort in which the electrocardiogram shows no abnormal changes should be examined roentgenologically using an abdominal compressor in order to confirm the presence of gastroesophageal regurgitation with or without a hiatus hernia.—*E. F. Lang, M.D.*

Albot, G., Toulet, J., Bonnet, G. F., and Moullart, C. Front and side-view cholecystography, with a study of the angle of vesicular erection, of the volume of the gall-bladder and of the volumetric coefficient of evacuation. *Am. J. Digest. Dis.*, Oct., 1953, *20*, 293–301.

The authors systematically studied gallbladders in multiple positions, especially in side views, front views and decubitus positions. The volume of the gallbladder was determined before and after Boyden's test. A study was made of the "function of evacuation" and the "function of vesicular contraction," measured by the "angle of erection" in side views.

The authors conclude that, with these precise facts, it is possible to perfect the roentgenologic diagnosis of vesicular dyskinesias, and to distinguish normal gallbladders, infundibulocystic hypertension, cholecystotomy, total vesicular stasis, and hypercontractile gallbladders.—*F. B. Markunas, M.D.*

Nemours-Auguste, and Barag, N. La cholangiocholécystographie intraveineuse; opacification des voies biliaires intra- et extra-hépatiques par une nouvelle substance. (Intravenous cholangiocholecystography; opacification of the intra- and extra-hepatic ducts with a new substance.) *Presse méd.*, Oct. 1, 1953, *61*, 1244–1245.

The authors examined 17 cases with a new substance, radioselectan, with no untoward effects. Radioselectan is Sodium-N-adipinodi-(3-amino 2, 4, 6, triiodo-phenyl-carbonate). It is a transparent, almost isotonic liquid, containing 20 per cent iodine. The first 2 cases received 20 cc. intravenously, and in the remaining 15 cases 40 cc. was injected at the rate of three to four minutes for each 20 cc. The contrast substance was found to be completely harmless and no incident was encountered in any of these patients, 1 of whom weighed only 92½ pounds. Fromhold examined 200 patients with the same product and only 1 nervous female patient suffered from vomiting.

Ten minutes after the injection of the opaque medium the branches of the hepatic duct and sometimes the hepatic duct itself become visible. Next the common duct is visualized in its entirety, which proves that the closure of the sphincter of Oddi is necessary for the filling of the gallbladder. The gallbladder starts to visualize within fifteen to twenty minutes after the injection and is very sharp at thirty minutes. The entire biliary tract remains visible for about two hours. After the fatty meal the gallbladder contracts and fills the cystic duct more rapidly than with the tetraiodide dye, in some cases in two minutes.

The authors recommend the right oblique decubitus position to avoid superimposition.

They conclude by saying that one can foresee the importance of radioselectan not only for cholecystography and cholangiography but also for the study of the function of the intra- and extrahepatic ducts. Since the publication of the work of Graham and Cole it is, in their estimation, the most important discovery for the study of the biliary ducts.—*S. Silvera, M.D.*

Keil, Philip, G., Hegstrom, Georg J., and Zoeckler, Samuel J. Cholangiography. *Ann. Int. Med.*, Sept., 1953, *39*, 479–483.

In this interesting paper the authors discuss a series of 55 cholangiograms done under direct vision during peritoneoscopy. The evaluation of hepatic and biliary disorders often requires liver function tests, needle biopsy of the liver and cholecystography before a definite diagnosis can be reached. They note that this simple procedure is most useful in the jaundiced patient where the general condition contraindicates exploratory laparotomy and where cholecystography has failed to give sufficient information. Thus it is possible in some cases to save a patient a major surgical procedure.

Their technique is to insert a 20 gauge needle through the abdominal wall into the fundus of the gallbladder while observing this area through the peritoneoscope. Once a free flow of bile is established 10–15 cc. of 35 per cent iodopyracet is injected. Mild spastic reactions are overcome with sublingual nitroglycerine. Cholangiograms are then obtained.

By visualization of the gallbladder, cystic and common ducts it has been possible to differentiate between intrahepatic and extrahepatic obstruction. In this series 10 patients were found to have calculi, 1 had a fistula between the fundus and the transverse colon, and 1 had an obstructing carcinoma of the head of the pancreas. The remaining cases were structurally normal, although associated disease of the liver was found in a large percentage.—*T. D. Allison, M.D.*

Martins, Jorge Dodsworth. Colangiografía operatória; experiência com 120 casos. (Operative cholangiography; experience with 120 cases.) *Rev. brasil. de gastroenterol.*, Sept.–Oct., 1953, *5*, 511–520.

The aim of operative cholangiography is to gain roentgenologic information regarding either the presence of calculi in the common duct or the obstruction in the region of the papilla Vateri.

The cases observed and described in detail by the author could be divided into the following categories: (1) cases of choledocholithiasis in which the common duct appeared open during cholangiography (14 cases); (2) cases of choledocholithiasis in which the common duct was open after use of operative cholangiography for control (12 cases); (3) cases in which cholangiography showed no calculi nor did the contrast medium pass into the duodenum (2 cases); (4) cases in which the common duct was open and in which no calculi were found either by instrumental exploration or by control cholangiography (19 cases); (5) cases in which cholangiography showed normal biliary ducts and the common duct was not open.

Operative cholangiography can be performed rapidly and offers no technical difficulties. It largely eliminates unnecessary choledochotomies and reduces secondary operations on the biliary tract.—*Ernst A. Schmidt, M.D.*

Moyson, Fr. Hépatite toxique après cholangiographie. (Toxic hepatitis after cholangiography.) *Acta gastro-enterol. belg.*, Oct., 1953, *16*, 646–650.

A fifty-nine year old patient with symptoms of fifteen years' duration had a cholecystectomy with a normal preoperative cholangiogram Thirty-six hours later the patient developed jaundice; laboratory studies and duodenal drainage indicated possible biliary obstruction. The patient was explored on the seventh postoperative day. The biliary system was not obstructed. Biopsy of liver tissue revealed changes indicating a toxic hepatitis.

Published observations on complications of cholangiography include cholangitis and multiple abscesses of the liver. These usually occur when *Esch. coli* is present in the gallbladder at cholecystectomy. Death may occur after a rather long interval, and this is usually due to intrahepatic abscess. When there is doubt concerning infection, only 3–5 cc. of a weak concentration of opaque medium (25 per cent) should be used in cholangiography.—*Charles Nice, M.D.*

Berenbaum, Morris, C., and Birch, C. Allan. Thorium deposits in the liver; demonstrated during life. *Lancet*, Oct. 24, 1953, *2*, 852–855.

A report is made of a patient who received 10 cc. of thorotrast in a vein of the leg twenty-three years previously. Deposits of radiopaque material were demonstrated in the liver. Upon needle biopsy these radiopaque spots proved to contain radioactive thorium.

The authors include 7 case reports of thorotrast deposits with fatal outcome, death being due to the radioactivity of thorium. They assert that the doses of thorotrast commonly used are carcinogenic, and make the point that the use of thorotrast as a diagnostic agent should be limited to difficult diagnostic problems in elderly patients, where its use may prevent or expedite a major operation.—*J. H. Harris, M.D.*

Muntean, E. Neue Ergebnisse der Röntgendigestionsprüfung. (Further results of the

roentgen digestion test.) *Fortschr. a. d. Geb. d. Röntgenstrahlen ver. m. Röntgenpraxis*, Sept., 1953, *79*, 329–332.

The roentgen digestion test is a method whereby disturbances of the enzymatic digestive processes are demonstrated roentgenologically. A pellet of barium is covered by a layer of that substance the digestion of which is to be tested (protein or fat). As soon as the surrounding layer is digested the barium scatters; in this way one can determine the place and time of the digestion of the substance to be examined.

This paper gives the result of such examination in 103 additional patients, other results having been previously published. The time necessary for the digestion of protein and fat was determined in different types of patients. When hyperacidity was present the time for digestion of the protein capsules was considerably less than in normal patients; the digestion time was longer than normal in cases of anacidity or low acid values. The results of the roentgen digestion test paralleled the results of the chemical test. Lengthening of the fat digestion time was found in hyper- and hypo-acidity of the stomach. When a cholecystogram showed an abnormal gallbladder the test usually was also abnormal, as it was after gastric resection.

Theoretical considerations as to the reason for abnormal results of the roentgen digestion test are given. Some of the possible indications for this new type of roentgen examination are discussed.—*Hans W. Hefke, M.D.*

Freye, K. Fortschritte der röntgenologischen Magendiagnostik mit Hilfe der Vergrösserungstechnik im Hartstrahlbereich. (Progress in the roentgen examination of the stomach by means of magnification and high voltage technique.) *Fortschr. a. d. Geb. d. Roentgenstrahlen ver. m. Röntgenpraxis*, Sept., 1953, *79*, 345–353.

High voltage (110–120 kv.) and a small focal spot of the tube allow an increase in the detail of the resulting roentgenogram. This type of technique is not only applicable in chest roentgenography but also in the relief study of the gastric mucosa. By decreasing the focus-object distance to about 25 cm. it is possible to magnify the image to twice the size obtained by the regular procedure. The relief pattern of the gastric mucosa is more brilliant and more detailed. This fact is of considerable significance for the early diagnosis of carcinoma of the stomach.—*Hans W. Hefke, M.D.*

Almy, Max A., Volk, Fred H., and Graney, Charles M. Situs inversus of stomach. *Radiology*, Sept., 1953, *61*, 376–378.

Situs inversus totalis occurs about once in 6,000 to 8,000 individuals.

This report concerns a patient in which there was inversion of the stomach alone. This is a very rare occurrence. The embryology is described. The anomaly was discovered at cholecystectomy and later confirmed by roentgenography. It is believed that right-sided stomach without total inversion of the viscera is of little clinical significance.—*Everett E. Seedorf, M.D.*

Abbot, Frank, and Blank, Samuel. Gastric ulcer—benign or malignant; preliminary report of a roentgenologic study. *New England J. Med.*, Oct. 29, 1953, *249*, 722–726.

The authors believe that with the use of careful roentgenologic examination and spot films of the mucous membrane pattern, the differentiation between a benign or malignant gastric ulcer can be made in a high percentage of the cases.

They present the criteria upon which they based their diagnoses in a series of cases. Lack of projection of the ulcer beyond the confines of the stomach was considered to be a malignant characteristic. The collar surrounding the ulcer pointed toward a benign ulcer if it was smooth. Radiating folds extending right to the ulcer crater were considered to be a benign characteristic. Folds that did not extend to the ulcer crater could be either malignant or benign. The presence of an overhanging edge was considered to be a definitely benign characteristic. Malignant ulcers had an irregular niche. An incisura opposite the ulcer was not indicative of practical value.

On the basis of these criteria the lesions were classified into three groups: (1) definitely benign or malignant; (2) probably benign, and (3) type undetermined. Where the authors were certain (Group 1), in the 22 cases in which there was histological proof they were 100 per cent correct. In the second group (probable) they were correct 91 per cent of the time.

Though this is a small series the authors believe that with excellent roentgenographic technique, the radiologist can differentiate between a benign and malignant gastric ulcer in a high percentage of the cases.—*Lawrence A. Davis, M.D.*

Cimmino, Christian V. Roentgenographically characteristic adenocarcinoma and leiomyosarcoma in the same stomach. *Radiology*, Sept., 1953, *61*, 373–375.

The roentgenographic finding of an adenocarcinoma and a leiomyosarcoma occurring simultaneously in the stomach is reported. An included figure of the roentgenogram shows the typical defect of a carcinoma in the distal end of the stomach and of an intramural extramucosal tumor proximally.

Attention is directed to the fact that multiplicity of cancers is a real possibility.—*Everett E. Seedorf, M.D.*

Gross, Kenneth E., and Durham, Milton W. Pyloric antral mucosal diaphragm; report of a case. *Radiology*, Sept., 1953, *61*, 368–372.

The authors report the roentgen detection and surgical finding of a hymen-like mucosal diaphragm stretching across the distal stomach 2 cm. proximal to the pylorus. Five illustrations depict the anomaly. The defect was believed to be congenital in nature. The embroyology is described. The roentgenological differential diagnosis is discussed.

The patient had been operated upon for numerous other presumed causes without relief. Following a Finney pyloroplasty, she remained asymptomatic and experienced no further episodes of intermittent vomiting.— *Everett E. Seedorf, M.D.*

Fox, Paul F. Duodenal obstruction in infants and children. *A.M.A. Arch. Surg.*, Sept., 1953, *67*, 475–489.

Twenty-one cases of duodenal obstruction were seen in infants and children at the Children Memorial Hospital, Chicago, from January 15, 1946 to January 15, 1953. They varied in age from one day to five years, 16 being twelve days old or less and 5 being three weeks, two months, seven months, fourteen months, and five years old respectively.

Seven cases had duodenal atresia, from one to five days of age (3 were premature), all female. Of the entire series 11 were female and 10 were male.

The roentgen findings in duodenal atresia were typical in 6 out of 7 cases with two fluid-air pockets, one in the stomach and one in the duodenum. The upright roentgenogram is a necessity for accurate evaluation of these cases.

The obstruction was complete in 7 cases of duodenal atresia; 5 had obstruction in the second portion of the duodenum distal to the papilla; 1 case was obstructed at the junction of the first and second portion of the duodenum and did not vomit bile; and 1case had obstruction of the third portion of the duodenum and vomited bile. Fourteen cases had partial obstruction. Twelve of these had adhesive bands across the duodenum, usually the second portion, extending from the posterolateral abdominal wall to the cecum in the right upper abdomen resulting in malrotation of the cecum. One case had stricture of the duodenum 2 cm. beyond the pylorus and 1 case had a membrane occluding seven-eighths of the lumen of the duodenum 2.5 cm. distal to the papilla. One of the 12 cases having adhesive bands also had a membrane partially obstructing the second portion of the duodenum which required reoperation.

In the differential diagnosis, hypertrophic pyloric stenosis must be ruled out. Here, the vomiting is projectile and there is no bile in the vomitus.

The operations which were done were as follows: duodenojejunostomy in 4 cases; gastroduodenostomy in 1 case; anterior gastrojejunostomy in 1 case; duodenojejunostomy and sigmoidostomy in 1 case; division of adhesive bands in 5 cases; reduction of volvulus and division of adhesive bands in 4 cases; and excision of obstructive membrane and transverse closure of the duodenal wall in 1 case. Five patients were reoperated: In 1 case a catheter jejunostomy was unsuccessful; in another case the operation disclosed no obstruction and roentgen examination of the chest showed a pneumonia which cleared up under treatment; 2 cases had secondary obstruction due to adhesions; 1 case had an obstructing membrane not discovered at the first operation and this was circumvented by duodenoduodenostomy.

The mortality rate in these series was 33.3 per cent.

In the discussion that follows one man reported 4 cases of complete atresia of the duodenum with no deaths. Another reported 11 cases with 4 deaths. Many of these patients have had other congenital anomalies, including mental deficiency in a fair number.—*Neal F. Yeomans, M.D.*

Wisoff, Carl P. Jejunogastric intussusception. *Radiology*, Sept., 1953, *61*, 363–367.

The author adds 2 additional cases of jejunogastric intussusception to the literature of over 100 such cases. Four types are described in the literature: (1) afferent loop intussusception, (2) efferent loop intussusception, (3) combined loop intussusception, and (4) retrograde intussusception following gastrectomy. By far the most common is intussusception of the efferent loop of the gastrojejunostomy.

Clinically, the symptoms are either acute, with colicky abdominal pain, nausea, and bile strained vomitus, or chronic, with periodic attacks of abdominal pain, nausea, and vomiting over a period of years. In the acute form, loop obstruction with progression to gangrene of the involved intestine leads to a high mortality if not promptly relieved.

The roentgen findings may be pathognomonic and consist of a circumscribed intraluminal defect in the stomach, the outer surface of which shows the concentric striations of valvulae conniventes, in a patient who has had a gastroenterostomy. Fluoroscopic appearance varies with degree of compression on the barium containing stomach. Other possible findings include dilatation of the stomach and/or afferent loop due to obstruction at the stoma, flattening or cranial convexity of the greater curvature, and displacement of the antrum to the right.

Both of the author's cases were of the chronic type. In one, the roentgen findings were confirmed at operation, during which a subtotal gastric resection apparently relieved the symptomatology. The other patient presented the usual symptoms and roentgen findings but was not subjected to surgery.—*Michael J. Healy, M.D.*

Cregg, Hugh A., and Smith, Frederick Goethe. Radiographic demonstration of localized mesenteric thrombosis; a case report. *Radiology*, Sept., 1953, *61*, 379–381.

A case is reported in which recurrent mesenteric thrombosis of the ileum was diagnosed roentgenographically and surgically proved.

The initial operation was done (without roentgen study) on the basis of a probable diagnosis of acute appendicitis. The postoperative course was satisfactory until the ninth day, when the patient was readmitted with recurrence of abdominal pain (of 12 hours' duration), moderate abdominal tenderness and hyperactive intestinal sounds. Roentgenograms (anteroposterior, supine and posteroanterior erect) showed absence of gas in the intestine with the exception of one small loop. In this loop, the mucosal pattern could be seen, and the thickened intestinal wall was visible, due to contrast with contiguous omental and mesenteric fat. There were no fluid levels. The ascending colon was displaced to the right by the inflammatory mass.

Similar roentgen signs might be observed with intramural mesenteric hemorrhage, intestinal strangulation, localized inflammatory disease, and neoplasia with vascular or lymphatic obstruction.—*Lynne J. Taylor, M.D.*

Kunstader, Ralph H., Guterman, Henry S., and Tulsky, Alex S. Transabdominal pneumoperitoneum as an aid in the diagnosis of sex-endocrine disturbances. *A.M.A. Am. J. Dis. Child.*, Sept., 1953, *86*, 275–283.

The authors state that any simple procedure is of value when it aids in establishing a clinical diagnosis without the aid of an exploratory operation. It is their aim in this paper to show how pneumoperitoneum can be adapted to children for such purpose in various sex-endocrine disturbances. Their technique is given in detail. In summary, it consisted of introducing a measured amount of CO_2 into the peritoneal cavity and then visualizing roentgenographically the outlines of the pelvic viscera. Patients, 16 in number, included cases of ovarian agenesis, precocious puberty, hypopituitarism, cystic ovary, intersexuality, and hypo-ovarianism. In an addendum they also report a case of pseudohermaphroditism in an eleven weeks old infant. In this case, female pelvic structures were clearly demonstrated and no untoward symptoms resulted from the procedure.

Ovarian enlargements were revealed in 1 case, in another a small uterus and also small ovaries were demonstrated. A table with summary of all clinical data, together with the roentgenological findings is included in the paper.

The authors regard the use of pneumoperitoneum as of value in the study of children with sex-endocrine disturbances because of the difficulty of adequate pelvic examination and the fact that an early diagnosis is desirable in order to plan future medical and/or surgical management.—*R. S. Bromer, M.D.*

Olivier, Cl., Arvay, N., and Ferrari J. Radiodiagnostic des occlusions du grêle par brides et adhérences. (Roentgen diagnosis of small intestinal obstruction due to bands and adhesions.) *Presse méd.*, Oct. 21, 1953, *61*, 1355–1357.

A study of 45 cases convinced the authors of the value of abdominal roentgenography in cases of ileus. Beyond the seventh hour, the films present the diagnosis of mechanical occlusion without difficulty. In only 1 of their cases were findings lacking, in 8 they were poor. The findings are complicated when there is an added strangulation.

Usually the site of obstruction can be determined. The common picture is that of gaseous distention of the small intestine with fluid levels. The large intestine is never distended alone and in only 2 cases was it distended along with the small intestine. When strangulation of the mesentery is added, there is a selective jejunal dilatation which can be confused with the left colon. Multiple constrictions have not been recognized. There is no certain way of differentiating simple occlusion and strangulation. In any doubt, barium enema examination should be performed. When essential, barium by mouth can be given safely in small quantities.—*M. L. Sussman, M.D.*

Heuck, F. Dünndarmveränderungen bei Askaridiasis als Ausdruck einer enteralen Allergie. (Small intestinal changes in ascariasis as an expression of enteral allergy.) *Fortschr. a. d. Geb. d. Röntgenstrahlen ver. m. Röntgenpraxis*, Sept., 1953, *79*, 318–322.

Ascariasis can be diagnosed roentgenologically by the typical filling defects, in the barium filled small intestine.

Allergic phenomena caused by the metabolic products of the ascarides can also be demonstrated. These include mucosal swelling and increased and decreased tonus of segments of the small intestine. When the ascarides have been removed from the intestinal tract such changes disappear.

Similar allergic changes can be produced by ingestion of an extract made from the parasite.—*Hans W. Hefke, M.D.*

Singleton, Arthur C. The Richards Lecture. Part I. *J. Canad. A. Radiologists*, June, 1953, *4*, 29–31. Some radiological aspects of cancer

of the colon. Part II. *Ibid.*, Sept., 1953, *4*, 49–60.

This article, published in two parts, constitutes the first Richards Lecture of the Canadian Association of Radiologists. Part I consists of a eulogy to the late Gordon E. Richards.

In Part II, the author points out the importance of early diagnosis in reducing the mortality of cancer of the colon. The necessity of investigating all causes of rectal bleeding is stressed and the combined use of sigmoidoscopy and barium enema study is advocated, especially since most carcinomas occur in the region of the rectum and sigmoid. The place of air contrast examination in the diagnosis of small colon lesions is discussed with particular reference to polypi. The technique of roentgenological examination of the colon is considered in some detail, with particular reference to the use of tannic acid in the barium suspension in order to demonstrate the mucosal pattern on evacuation films, and to the use of a high kilovoltage technique with dilute suspensions of barium as recommended by Gianturco.—*Edward F. Dunne, M.D.*

GYNECOLOGY AND OBSTETRICS

COOK, DANIEL G., and BUTT, JOHN A. Hysterosalpingography studies following ectopic pregnancy. *Am. J. Obst. & Gynec.*, Sept., 1953, *66*, 626–636.

In a review of a series of 70 ectopic pregnancies operated upon at the Cleveland City Hospital, it was noted that 7, or 10 per cent, were repeat operations for the same lesion of the residual tube. Fourteen of the 63 patients had sterilizing procedures at the time of the first laparotomy (usually resection of the uninvolved tube for obvious salpingitis) giving an incidence of repeat ectopic tubal pregnancy of 14.3 per cent.

The total number of studies by salpingography was 25. There were 8 patients with little or no demonstrable pelvic pathology at surgery besides their ectopic pregnancy who were shown to have demonstrable tubal defects on salpingography.

The authors were unable in this series to indict remote surgery, genital tuberculosis, or the hematosalpinx which is occasionally present in the uninvolved tube as causes of postectopic tubal damage. The offenders were pelvic inflammatory disease and the ectopic pregnancy itself. In a total of 9 cases (5 of the occluded group and 4 of the patent group) pelvic inflammatory disease was present. There were 8 cases in which the ectopic surgery itself was the evident cause of postoperative tubal abnormalities.

The advisability of employing hysterosalpingography as part of the routine follow-up of all patients operated upon for ectopic tubal pregnancy is emphasized. Not only is it helpful in informing the patient of her prognosis for future pregnancies but it also gives the operator an unexcelled opportunity to study by hysterosalpingography the pelvis he has already examined by surgery.—*Eugene J. McDonald, M.D.*

CRICK, A. F., and SIMS, F. H. Gas within the foetus indicating foetal death. *J. Fac. Radiologists*, Oct., 1953, *5*, 126–133.

This paper emphasizes the importance of gas within the fetus as a sign of intrauterine death.

Seven cases, occurring within a period of seven months, are reported. In 2 cases the gas was not confined to the vascular system, being also present in the peritoneal cavity and stomach. Laboratory investigations in 4 of these cases failed to reveal evidence of gas-forming organisms in the fetal heart blood. Analysis of gas removed from the heart cavity and from the peritoneal cavity of various fetuses concerned with this report showed that the gas was almost wholly nitrogen, irrespective of the site from which it was obtained. In the 7 cases reported, the presence of gas was proved in 6, while in the seventh case there was definite roentgen evidence of gas in the heart on several examinations prior to delivery, the gas collection gradually decreasing, until on the fourteenth day after first being seen it was no longer evident on the films. In 4 of the 7 cases Spalding's sign of fetal death—overlapping of the fetal cranial bones in the absence of labor—was not present. Consequently, the authors regard gas as a valuable sign of fetal death. They emphasize the importance of a careful search for this sign, and the use of the lateral projection for most satisfactory demonstration of fetal gas in utero.—*Samuel G. Henderson, M.D.*

RIVA, H. L., ANDRESON, PAUL S., and O'GRADY, JOHN W. Pregnancy and Hodgkin's disease; report of eight cases. *Am. J. Obst. & Gynec.*, Oct., 1953, *66*, 866–870.

The authors were able to find in the American literature a total of 65 reported cases of pregnancy complicating Hodgkin's disease.

The present article deals with detailed case reports of 8 additional patients seen at the Walter Reed Army Hospital during the past six years. The incidence of Hodgkin's disease in pregnancy at Walter Reed Army Hospital was 0.97 per 1,000 deliveries.

The authors, in summarizing their observations in the 8 cases reported, state that it seems that fertility was not affected by the disease; that no spontaneous abortion occurred; that there was no tendency to hemorrhage; that the placentas showed no abnormality; and that there was no evidence of specific increase or exacerbations of the Hodgkin's disease during the pregnancy. In 1 case nitrogen mustard was given in the first eight weeks of gestation and in 5 others radiation therapy was used at some

time during the pregnancy and all infants born to these mothers are normal.—*Ralph F. Niehaus, M.D.*

Genitourinary System

Camerini, R., Zaffagnini, V., and Lolli, G. Tomography as a research means of bladder walls. *Radiol. clin.*, Sept., 1953, *22*, 421–424.

The authors use laminagraphy in combination with presacral retropneumoperitoneum and gas insufflation of the bladder to demonstrate the contour of the bladder wall.

The presacral retropneumoperitoneum is performed in the ordinary manner by injecting about 500 to 600 cc. of oxygen. The vesical insufflation is carried out immediately after the retropneumoperitoneum, the quantity of air of oxygen used varying between 50 and 200 cc. Both procedures are done under fluoroscopic control and the laminagrams are made as rapidly as possible to avoid diffusion of the pelvic gas into the upper retroperitoneal spaces. The authors' experience includes only laminagrams in the anteroposterior and posteroanterior projections with the patient in horizontal and Trendelenburg positions but they state that laminagrams in other planes may also be taken.

The method, besides that it eliminates superimposition of shadows from the neighboring organs, is particularly valuable in demonstrating alterations of the bladder wall and the extravesical extension of malignant neoplasms of the bladder and of other pelvic tumors.—*T. Leucutia, M.D.*

Stewart, Charles Montgomery. Delayed cystograms. *J. Urol.*, Oct., 1953, *70*, 588–593.

The purpose of this article is to stimulate further investigation into the physiology of the ureterovesical junction.

The author used cystograms made at fifteen to thirty minute intervals over a period of three hours following the intravesical instillation of 15 to 20 per cent urokon. Ureteral reflux was noted in instances when accepted theories militated against it and, conversely, reflux could not be demonstrated when from other evidence, such as cystoscopy, one might have expected to find it. In some instances overdistention of the bladder produced unilateral or bilateral reflux which, after an interval of a few minutes, disappeared and recurred. It is suggested that such observations be corroborated by further studies.—*George W. Chamberlin, M.D.*

Bunge, Raymond G. Delayed cystograms in children. *J. Urol.*, Nov., 1953, *70*, 729–732.

The author believes that this procedure is worth while, particularly in certain patients who have unexplained recurrent urinary tract infections. By the use of delayed cystograms, certain observations on the physiology of the ureterovesical junction can be made which are not possible by any other known method. The consequences of failure to recognize ureteral reflux may be grave both to the patient and to the clinician. The work of Bunge confirms the observations of Stewart (see above abstract).

The technique is as follows: An intravenous urogram is done in the routine manner. If this fails to reveal any disease, delayed cystograms are done on the following day. Seventy-five to 150 cc. of a 10 per cent solution of skiodan is instilled into the bladder by a catheter. No effort is made to overdistend the bladder. The amount used varies. A feeling of fullness is the principal clinical guide. The catheter is withdrawn and a film exposed in the anteroposterior projection over the bladder and kidneys. The patient is then allowed ambulation and exposures are made thirty and sixty minutes after the instillation. In 5 normal children no ureteral reflux was seen. In 11 patients with some evidence of urinary tract abnormality reflux was noted.

The author does not speculate on the cause of the phenomenon, but further investigations are being made.—*George W. Chamberlin, M.D.*

Roberts, Henry. Observations on micturition in the female. *J. Obst. & Gynaec. Brit. Emp.*, Oct., 1953, *60*, 621–631.

Two hundred and twenty women, continent and incontinent, parous and nulliparous, were investigated by cystoscopy, cystometry and cystourethrography, and the urinary apparatus in cadavers of all ages was examined by naked eye dissection and serial section microscopy. The results and inferences are assembled and correlated with other observations from the literature to present a composite picture of the mechanism of micturition, and of its disturbances, in women.

An attempt is made to integrate the anatomical, roentgenologic and cystometric findings in order to trace the sequence of events that occurs in the bladder and urethra during micturition. Micturition is initiated by a momentary holding of the breath, contraction of the abdominal muscles and diaphragm and, what is more important, by an *active* relaxation of the pelvic muscular diaphragm. Relaxation of the pelvic floor allows the urethrovesical junction to move downwards and backwards. Immediately afterwards, and possibly because this movement of the urethrovesical junction acts as a trigger, the detrusor muscle of the bladder is released from its inhibition. Contraction of the detrusor results in the bladder becoming ovoid in shape and this raises the intravesical pressure still farther.

Varying degrees of descent of the bladder base and upper urethra in cases of prolapse are easily demonstrated by lateral cystourethrography. As reported elsewhere, loss of the posterior urethrovesical angle, either at rest or on straining, is a characteristic of stress incontinence. No matter how gross

is the dislocation of the upper urethra and bladder from its retropubic position in prolapse *without* stress incontinence, the posterior urethrovesical angle is preserved and the relationship of the upper urethra to the bladder is normal.

Occasionally, diurnal frequency may in part be explained by incomplete emptying of the bladder—a feature of gross cystocele. Urgency incontinence differs from stress incontinence in that (a) it may occur without physical stress and is accompanied by contraction of the detrusor muscle, (b) a strong and urgent desire to pass urine is present immediately before incontinence, (c) the volume of fluid which escapes at any one time is much larger, and (d) leakage only occurs when the bladder is full, whereas stress incontinence can be demonstrated when the bladder contains only a small quantity of fluid.

Stress incontinence occurs when the posterior urethrovesical angle is temporarily or permanently obliterated—that is, when the change characteristic of micturition occurs at rest or under stress.—*Eugene J. McDonald, M.D.*

Hodgkinson C. Paul, and Doub, Howard P. Roentgen study of urethrovesical relationships in female urinary stress incontinence. *Radiology*, Sept., 1953, *61*, 335–345.

The authors present a study of the roentgenologically demonstrable changes encountered in women with urinary stress incontinence.

The configuration of the urethra was demonstrated by means of an intra-urethral metallic bead chain. Skiodan was used for visualization of the bladder outline. Anteroposterior and lateral roentgenograms were taken. Two phases of bladder physiology were investigated—resting and straining. Three groups of patients were studied: (1) Nonparous women, (2) women with no urinary complaints but with varying degrees of relaxation of the support of the lower urinary tract as a result of parturition, and (3) patients complaining of urinary stress incontinence.

Normal nonparous women depend upon an intact, adequately functioning sphincter mechanism for control of urine. Parous patients without stress incontinence show backward and downward rotation of the bladder, as the result of stress, with elevation of the internal urinary meatus to a position along the anterior bladder wall. This brings the internal urinary meatus away from the point of maximum hydrostatic pressure. In patients with urinary stress incontinence, the internal urinary meatus remains in the area of maximum hydrostatic pressure during the straining effort.—*Arno W. Sommer, M.D.*

Pyrah, L. N., and Smiddy, F. G. Pararenal pseudo-hydronephrosis: a report of two cases. *Brit. J. Urol.*, Sept., 1953, *25*, 239–246.

Pararenal pseudo-hydronephrosis is a rare condition resulting from injury to the renal parenchyma or the renal pelvis. According to the authors, "it consists of a false pararenal cyst, containing urine and communicating with the renal calyces or pelvis by way of a tear either of the renal pelvis itself or more commonly of the entire thickness of the renal parenchyma. A cystic swelling develops in the loin, occasionally quite rapidly but usually more slowly during the months after the injury; the kidney gradually ceases to function and may slowly undergo complete pressure atrophy."

This article gives a detailed report of 2 cases. One of the cases, a boy twelve years old, sustained a rupture of the kidney following a crush injury of the abdomen. The other case, a female aged thirty-nine, developed the condition following accidental tear at the pelvo-ureteric junction during an operation for removal of a calculus in the renal pelvis. Diagrammatic representations of the findings at surgery are presented in both cases. In addition, there are excellent reproductions of pre- and postoperative roentgenograms of Case 2. Also, a photomicrograph from a section of the wall of the cyst in Case 2 is included.

A review of the literature revealed that in most of the recorded cases (24 up to 1941) pararenal pseudohydronephrosis complicated a ruptured kidney associated with a crushing injury. The authors were unable to find a case in the literature similar to their second patient in whom the pararenal pseudohydronephrosis followed the removal of a stone from the renal pelvis.

The clinical picture is characterized by the fact that, since often temporary improvement follows a ruptured kidney, there may be a large, slightly tender, fluctuant mass in the loin by the time the patient is seen by the surgeon. In some cases, the mass extends from the diaphragm to the true pelvis and across the midline of the abdomen. The urine usually does not contain pus and organisms and there is no hematuria where cystoscopy has been done; there has been without exception no secretion of urine from the affected side.

In concluding, the authors state that the factors necessary for the production of pararenal pseudohydronephrosis are (1) a complete rupture of the renal parenchyma into the calyx-pelvis system or alternatively a rupture of the renal pelvis, (2) local conditions leading to the maintenance of the opening produced by the injury beyond the period needed for healing, and (3) ureteric obstruction. The treatment is excision of the cyst with nephrectomy. Drainage alone is unsatisfactory. It may be possible to save the kidney in an early case.—*Ralph F. Niehaus, M.D.*

Faingold, Joseph E., Hansen, Cyrus O., and Rigler, Leo G. Cystitis emphysematosa; review of the literature and report of four cases diagnosed by roentgen examination. *Radiology*, Sept., 1953, *61*, 346–354.

Only 16 cases of cystitis emphysematosa recog-

nized during life have been recorded in the literature. The authors report 4 more cases recognized by roentgen examination during life.

Cystitis emphysematosa is an inflammatory condition of the urinary bladder associated with gas vesicles in the tissues. The etiology is still controversial but it is thought that bacteria, mainly of the *B. coli* group, play an important role. Hyperglycemia is also believed to be a contributing factor favoring bacterial growth.

Pathologically many gas-containing vesicles in the bladder wall are found, and there may be gas dissemination throughout the interstices of the connective tissue. The bladder shows evidence of acute or chronic inflammatory changes. Microscopically most of the vesicles have no cellular lining which differentiates this condition from cystitis cystica.

Cystoscopically these thin-walled vesicles are easily demonstrated, and may often be found to rupture and the released gas seen to arise to the dome of the bladder.

It is a disease of adult life and the symptoms usually are frequent urination and dysuria, with hematuria at times. Rarely is pneumaturia present. Some of the cases reported were found in untreated diabetics with high blood sugar.

The roentgen findings are quite characteristic and consist of visualization of a concentric or semilunar ring of radiolucency outlining the circumference of the urinary bladder. Gas may often be demonstrated within the lumen of the bladder. When the bladder contracts the zone of gas follows the bladder wall and may disappear entirely due to rupture of the thin-walled vesicles.—*Donald N. Dysart, M.D.*

Skeletal System

Veller, K., and Laur, A. Zur Ätiologie der infantilen kortikalen Hyperostose (Caffey-Syndrom). (Etiology of infantile cortical hyperostosis [Caffey's syndrome].) *Fortschr. a. d. Geb. d. Röntgenstrahlen ver. m. Röntgenpraxis*, Oct., 1953, *79*, 446–452.

Caffey's syndrome is characterized briefly by the following: acute onset, indurated painful soft tissue swelling in the extremities, face, particularly over the mandible simulating mumps, clavicle, scapula, ribs, and seldom also in the metatarsus and phalanges. The swellings may be uni- or multilocular, may occur simultaneously, or frequently at intervals. Clinically, there is fever, leukocytosis with relative lymphocytosis, irritability, anorexia, and abnormal position of the joints. Roentgenologically, there is periosteal proliferation in various degrees limited to the diaphyses of the long bones. Not infrequently there is anterior bowing of the tibia. Those children affected are usually under one year old, particularly during the first four months. The cause of the disease is not known. The prognosis is favorable. The lesions usually disappear within several weeks or months, while widening of the shaft, medullary widening, and slight bowing may remain somewhat longer. Cases have been described in sisters, and the question of this being a familial disease has been raised.

A case of a nine week old female child demonstrating the findings characteristic of infantile cortical hyperostosis is presented. Review of the hospital records of the father of the child suggested that he had the same disease when he was four weeks old. A biopsy of the periosteal reaction (1929) was diagnosed as productive periostitis, of unknown etiology. The possibilities suggested at that time were scurvy, lues, leukemic reaction, and osteomyelitis. The condition cleared completely within nine months and roentgenograms twenty-three yerars later revealed a normal skeleton.

Various theories as to the etiology of this disease have been presented, the most common one being that of infection. Most of the available evidence is against this possibility. The authors stress the theory of familial transmission of the disease. Review of the literature and the authors' case report confirms this impression.—*Samuel Richman, M.D.*

Schröder, W. Jugendliche Spongiosklerose. (Adolescent spongiosclerosis.) *Fortschr. a. d. Geb. d. Röntgenstrahlen ver. m. Röntgenpraxis*, Oct., 1953, *79*, 436–446.

The gross structure of the bones on the roentgenogram is determined by the shape and thickness of the cortex and by the various types of spongiosa. In the long bones, the trabecular and lamellar spongiosa plays the major role. The thickness of individual trabeculae and the width of the interstices fluctuate considerably in various portions of the skeletal system. Also, in different individuals, depending upon age, sex, and constitution, there are large variations.

The question whether the roentgenogram depicts sufficiently truly the trabecular thickness and width of the bony mesh, considering the above named normal variations, so that a diagnosis of noncharacteristic bone changes can be made, may be answered only with qualifications. The noncharacteristic bone changes are hyperostosis, osteosclerosis and osteoporosis. Spongiosclerosis which is a form of endosteal hyperostosis, represents a particular type. Relative spongiosclerosis is seen as an increase in volume and thickness of the trabeculae, with simultaneous diminution in their number. Thus, the mesh space between the trabeculae is widened. This type of spongiosclerosis may be seen frequently in the healing stage of Sudeck's syndrome or other similar secondary trophic reparative processes. A relationship between generalized hyperostosis, osteosclerosis, and osteoporosis with diseases of the bone marrow may be present, but frequently there may be no clinical correlation.

A case is presented in which there was striking spongiosclerotic structural deviation of various long

bones, most marked in the right distal half of the femur. There was no periostitis. This patient, a thirteen year old boy, had sustained a fracture of the neck of the right femur after a relatively minor injury.

It is believed that the above described bone variations have a close relationship to the physiological growth changes of the bones. Other authors have noted long streaks of bone 1 to 3 mm. thick in the femur. During the period of maturity of the child, there is a transition from the red bone marrow of the diaphysis into fatty marrow, and then frequently there exists a considerable disproportion between the degree of growth and of the arteries. The factor of heredity must also be considered, since growth and the form of the bones are determined by the factor of heredity. The striped form of osteopoikilosis, which is similar to spongiosclerosis, has been found in several members of one family. In the case presented here, a skeletal survey of the father suggested a cystic honeycomb appearance, surrounded by saucer-like sclerosis, in the neck of the right femur.

To summarize the findings in this single case report, it may be stated that there was a string-like spongiosclerosis, localized particularly in the tibia and femur, which exceeded the normal variation. This spongiosclerosis simulates, on the one hand, the streaky form of osteopoikilosis, and on the other hand, it has similarities to the streaked sclerosis and punctate thickening which occur in the growth period and is of no pathological significance. The possibility of a tendency to fracture after slight trauma must be considered. Transitory complaints referable to the knees appear to occur, otherwise no other symptoms have been noted.—*Samuel Richman, M.D.*

Ingram, Alvin, J., and Bachynski, Borden. Fractures of the hip in children; treatment and results. *J. Bone & Joint Surg.*, Oct., 1953, *35-A*, 867–887.

Fractures of the hip in children, although rare, are associated with an excessive incidence of complications in all reported cases. Those most commonly encountered are avascular necrosis, nonunion, malunion, and disturbances of growth. Twenty-four cases were studied in the series reported in this paper. The fracture was the result of severe trauma in 17 cases, the result of lesser trauma (moderately severe) in 3 cases, and in 4 instances, it was the result of lesser trauma being applied to an extremity weakened by a pre-existing pathological condition: poliomyelitis, 2; fibrous dysplasia of the femur, 1; and disuse atrophy from rheumatic fever, one.

The cases were classified according to an anatomical classification developed by Delbet. Type I, or transepiphyseal fractures, occur at the level of the capital femoral epiphyseal line. This fracture is not to be confused with slipping of the capital femoral epiphysis inasmuch as it is an acute traumatic separation of a previously normal epiphysis. Type II, or transcervical fractures, occur through the middle of the femoral neck. Type III, or cervicotrochanteric fractures, occur at the base of the neck of the femur and, Type IV, or intertrochanteric fractures, occur between the base of the neck of the femur and the lesser trochanter.

In their summary the authors give the following indications for treatment of these fractures:

Type I. Transepiphyseal fractures:

A. Without dislocation of the femoral head: gentle closed manipulation and insertion of two or three parallel Knowles pins. The capsule of the hip should not be opened.

B. With dislocation of the femoral head: open reduction, internal fixation with two or three Knowles pins, and prolonged non-weight bearing.

Type II. Transcervical fractures: gentle closed manipulative reduction and insertion of two or three Knowles pins. The capsule of the hip should not be opened.

Type III. Cervicotrochanteric fractures:

A. If fragments are separated: gentle closed manipulative reduction and insertion of two or three Knowles pins.

B. If fragments are not separated: a Hoke-Martin traction cast, or a Whitman abduction cast.

Type IV. Intertrochanteric fractures: gentle closed manipulative reduction and application of a Hoke-Martin traction cast.

The triflanged nail, although eminently satisfactory in adults, is less desirable in children because the density of the femoral head and neck presents certain mechanical problems. Of the 21 fractures of the series which united, 2 healed in the coxa vara position and 17 healed in satisfactory alignment. Of the 17 patients who were followed for more than one year, avascular necrosis of the capital femoral epiphysis occurred in 6 instances. The 6 patients with fracture through the epiphyseal plate (the only such group the authors were able to locate in the literature), had worse results than any group of patients previously reported, regardless of treatment. In those patients in this series, in whom avascular necrosis developed, this complication was unmistakably apparent in roentgenograms made between ten and twelve months after operation in all cases.—*Ralph S. Bromer, M.D.*

Platou, Eivind. Luxatio coxae congenita; a follow-up study of four hundred and six cases of closed reduction *J. Bone & Joint Surg.*, Oct., 1953, *35-A*, 843–866.

This paper is a report of a follow-up study of 406 cases of congenital dislocation of the hip treated by closed reduction. It is illustrated with roentgenograms of cases, showing end results and numerous tables showing results of follow-up examinations, age distribution, clinical results, roentgenographic re-

sults, etc. In the series of 406 hips with a control period ranging from three to thirteen years, clinically good results were obtained in 80.8 per cent and roentgenographically good results in 66 per cent. As regards age of the patient, the younger the patient at the time of treatment, the better was the result.

From the age of one year, there is normally a distinct bone nucleus in the head, but in children with congenital dislocation it varies both in size and form and may be absent entirely up to the age of three. The study of the series showed that children with normal bone nuclei have a somewhat better chance of a good result. A very large acetabular angle, 40 degrees or more, had no significant influence on the late results. The severe dislocations yielded poorer results than the slight ones. The degree of dislocation thus has some prognostic value.

Platou regards reduction trauma as undoubtedly of considerable significance. A difficult reduction involves greater injury to the femoral head and the late results showed that after an easy reduction good results were obtained in 68 per cent of cases as compared with 49 per cent of good results after a difficult reduction. The conclusion is reached that if an experienced operator cannot put the femoral head into position after two or three attempts, no further attempt should be made and the hip should be reduced by surgery two weeks later.—*Ralph S. Bromer, M.D.*

Bloom, Joseph. Osteitis condensans ilii. *J. Canad. A. Radiologists*, Sept., 1953, *4*, 61–65.

The author presents 2 cases of osteitis condensans ilii which responded well to deep roentgen therapy after failing to show improvement with conservative management. Both patients complained of low back pain and were given 1,600 r in air using two portals with 2 mm. Cu and 1 mm. Al filtration. Symptomatic relief was obtained in each instance and 1 case showed diminution in the amount of bone involvement on subsequent roentgenographic examination. Since his paper was written, the author has treated 3 additional cases with equally favorable response.

The author believes that his results justify a course of deep roentgen therapy in those instances in which no improvement occurs on conservative measures before resorting to surgical fusion of the sacroiliac joints.—*Geno DiBagno, M.D.*

Dahlin, David C., Wells, Arthur H., and Henderson, Edward D. Chondromyxoid fibroma of bone; report of two cases. *J. Bone & Joint Surg.*, Oct., 1953, *35-A*, 831–834.

Two cases of chondromyxoid fibroma of bone are reported in this paper, and in an addendum to the paper, the authors state that 6 additional examples of this lesion were uncovered in a comprehensive study of bone tumors in the files of the Mayo Clinic. In their cases the chondroid areas and the pseudolobulation with condensation of cells at the well demarcated border of the neoplasms served to differentiate the tumors from so-called myxoma of bone. The myxoid features, the pattern of growth and the peripheral demarcation without extension of the tumor between the trabeculae of the surrounding bone served to differentiate them from chondroma or chondrosarcoma. The benign clinical course as illustrated in the original series described by Jaffe and Lichtenstein and by the authors' first case, makes the differentiation from chondrosarcoma important.

Three clinical features of importance are associated with these tumors: (1) pain has been a complaint in all recorded cases; (2) the majority of patients have noted a palpable mass in the region of the tumor; (3) the mass may be tender to palpation and tenderness may be present in the absence of swelling.

Roentgenographic examination reveals a circumscribed zone of decreased density which may be confused with such lesions as fibrous dysplasia, bone cyst, and enchondroma. The rarefied area is sometimes trabeculated. Jaffe and Lichtenstein attributed this appearance to the inner boundary of the tumor which may be distinctly grooved and even somewhat sclerotic. If the cortex has been broken through, the bony contour may bulge and a thin layer of periosteal new bone may cover the neoplasm.

The treatment of choice as stated in the paper appears to be curettage.—*Ralph S. Bromer, M.D.*

Compere, Edward L. The diagnosis and treatment of giant-cell tumors of bone. *J. Bone & Joint Surg.*, Oct., 1953, *35-A*, 822–830.

Compere states that errors of diagnosis or classification of giant-cell tumors of bone are frequent and the controversy about the so-called variants is still rampant. Genuine giant-cell tumor is not so benign as it was once thought to be. Recurrence after treatment is not uncommon and malignant manifestations do occur. It must be differentiated from all other lesions which also contain multinuclear giant cells, including solitary bone cyst, nonosteogenic fibroma of bone, aneurysmal bone cyst, chondromyxoid fibroma of bone, benign chondroblastoma and the "brown tumors" sometimes found in hyperparathyroidism.

Among the findings in typical giant-cell tumors of bone are the following:

1. The patients are nearly all young adults. (The average age in a large series was found to be 28.4 years.)

2. The majority of giant-cell tumors originate in the end of long bones in the portion which during the growth years was the epiphysis.

3. Pain, often present at night as well as during activity, is common. By contrast, there is almost never pain associated with a solitary bone cyst, fibrous dysplasia, nonossifying fibroma and other

conditions which the pathologist sometimes erroneously diagnoses as giant-cell tumor.

4. Tumefaction is present early and is usually palpable and tender.

5. The expanded cortex of the bone is often paper-thin and may crackle when palpated.

6. Roentgenograms show a circumscribed osetolytic but expansile tumor and most uncommonly the thin expanded cortex of the bone is perforated. The larger giant-cell tumors may appear multinuclear, and the roentgenograms have been described as having a "soap-bubble" appearance.

7. Roentgenograms rarely reveal any periosteal reaction such as is present in many other types of bone lesion.

8. The stromal cells in a giant-cell tumor of bone show evidence of greater activity in growth and multiplication and in variety of morphology than do stromal cells of most other lesions which commonly contain giant cells.

9. Stromal cells as well as giant cells in a true giant-cell tumor contain acid phosphatase and contain no alkaline phosphatase.

10. Giant cells in a bone cyst, in fibrous dysplasia, or in nonossifying fibroma and other similar lesions are fewer in number. They may contain acid phosphatase, but the stromal cells of lesions which are not true giant-cell tumors contain only alkaline phosphatase and never acid phosphatase.

Each of the ten characteristics listed may be present in a single large giant-cell tumor. Compere believes that unless several of these typical findings are present in any given tumor, he is not dealing with a true giant-cell tumor.

Two cases are reported which Compere states show the folly of trying to destroy large giant-cell tumors by roentgen therapy. He states the degree of success of irradiation of a giant-cell tumor is determined for the most part by the size of the tumor. Some small giant-cell tumors may be completely destroyed by roentgen therapy, with resultant healing of the lesion. While the risk is small that sarcoma may develop in tissues irradiated in the treatment of giant-cell tumors, he believes the possibility cannot be ignored. Excessive irradiation has resulted in extensive damage to skin, muscles and other soft tissues surrounding the tumors, with only partial destruction of the giant-cell tumors. Usually, portions of the tumor continue to grow, so that the size increases in spite of the fact that some of the tumor may have been necrosed by the roentgen therapy. In his summary, Compere states that most giant-cell tumors may be adequately and safely treated by surgery, followed in some instanced by radiation therapy.—*Ralph S. Bromer, M.D.*

Ivins, John, C., and Dahlin, David C. Reticulum-cell sarcoma of bone. *J. Bone & Joint Surg.*, Oct., 1953, *35-A*, 835–842.

The opening sentence of this paper states that reticulum-cell sarcoma of bone is one of the entities which has been rescued from the Ewing's tumor "waste basket." Histopathological recognition of this relatively newcomer assumes more than didactic importance because of its better prognosis as contrasted with most primary malignant bone tumors. The gross appearance of reticulum-cell sarcoma of bone does not differ remarkably from that of some of the other lytic malignant processes of bone as, for example, highly anaplastic fibrosarcomas, metastatic deposits, or Ewing's tumors. In the region of the involvement, variable, usually moderate, destruction of bone occurs. Subperiosteal reactive new-bone formation, similar to that observed in chronic osteomyelitic processes or even in Ewing's tumors may be seen. This appears to be attributable to elevation of the periosteum by the growing tumor. The extraosseous extensions of the neoplasm may be soft and friable as is, for example, reticulum sarcoma which arises in lymph nodes. Often, however, considerable collagen within the neoplasm makes it rather firm. The central portion may be necrotic and the advancing edges of the tumor tend to be indistinct.

Microscopically, the diagnostic cell of this neoplasm is the reticulum cell which differs in no recognizable manner from that in reticulum-cell sarcoma of soft-tissue origin. This cell has an indented or lobulated nucleus. Its chromatin is rather coarse and one or more nuclei are usually present. The cells vary somewhat in size and nuclear hyperchromatism, but the basic morphological characteristics are otherwise the same. Special stains for reticulin have not aided the authors in diagnosis in troublesome cases. Many of these tumors contain fairly large numbers of lymphocytes. This feature is important to remember since it creates the danger, at biopsy, of mistaking a small specimen from one of these tumors for inflammatory tissue. This mixture of lymphocytes, lymphoblasts, and reticulum cells is often seen in comparable malignant growths of lymph nodes.

In a survey by the authors of 2,000 specimens of primary bone tumors, 49 were found to be reticulum-cell sarcomas. The survey reinforced their opinion that reticulum-cell sarcoma is a firmly established entity. It is important to confirm the diagnosis by adequate biopsy. Unlike other primary malignant tumors of bone, reticulum-cell sarcoma appears to be radiosensitive and in one of the authors' cases in which the tumor disappeared, Coley's toxins was the only treatment. At present, it appears that the prognosis in cases of reticulum-cell sarcoma of bone is significantly better that that in most other primary malignant tumors of bone.—*Ralph S. Bromer, M.D.*

Curtis, Raymond M. Congenital arteriovenous fistulae of the hand. *J. Bone & Joint Surg.*, Oct., 1953, *35-A*, 917–928.

Three cases of arteriovenous fistulas in the hand

are reported in this paper. Multiple arteriovenous communications in the hand have their origin in congenital remnants of the embryonic anlage of the arteries and veins. However, such abnormal communications may also develop from the normal arteriovenous communications which occur in the hand and are known as the neuromyo-arterial glomus. In such event, this structure becomes uncontrolled as a result of damage. In 1 of the 3 cases arteriovenous fistulas developed in a finger after a burn became infected. This may be an example, the author thinks, of the latter type of pathogenesis.

The diagnosis, he believes, is best made by an arteriogram since it shows the site of the abnormal communications. He quotes Allen and Camp who described the following characteristic findings in the roentgenogram: (1) dilatation of the arteries leading to the fistulas; (2) absence of normal filling of the arteries distal to the fistulas; (3) pooling of the arteriographic medium in the region of the fistulas. The pattern made by the contrast medium is suggestive of snowflakes in the region of the communications. (4) Appearance of the contrast medium in the veins distal to the point of injection in the first roentgenogram, while the proximal arteries are still occluded, indicates an arteriovenous fistula.

Excruciating pain in an area of ulceration was a constant finding in the 3 patients and this was not relieved until healing had occurred. Although it may not be possible to eradicate every one of the tiny arteriovenous communications in a given patient, Curtis believes that in most instances where the process is localized, the communications can be eradicated sufficiently to allow healing to take place and to prevent progressive gangrene and loss of function of the hand. He emphasizes that it is of utmost importance to recognize the clinical entity early and to institute radical surgical treatment before the process causes irreversible changes in the extremity. In 1 of his patients such an irreversible change had taken place and an amputation of the involved finger was necessary. In the other 2 cases, adequate excision preserved the remaining hand function.—*Ralph S. Bromer, M.D.*

Carroll, Robert E. Osteoid osteoma in the hand. *J. Bone & Joint Surg.*, Oct., 1953, *35-A*, 888–893.

Tumors of the hand in general are not common. In this paper, 6 cases of osteoid osteoma in the hand are reported. The patients who develop these lesions are usually young, in the second and third decades of life. They are fairly evenly distributed between male and female. No history of antecedent infection in the affected area or in the body has been found. The general health is good.

The roentgenographic appearance of osteoid osteoma is by far the most pertinent factor in the diagnosis. There is generally diffuse sclerosis of the involved bone. The central nidus may appear as an area of lucency. This area usually attains the size of a pea. In the small bones of the hand, however, the author found the nidus may appear in a different form, presenting a granular opacity. Surrounding this is a perimeter of radiolucency, separating the nidus from the surrounding sclerotic bone. In the literature, this form of nidus has been called a "ring sequestrum." A radiolucent nidus may change with time so as to present a picture of central isolated opacity.

There are three locations for the nidus of osteoid osteoma. Location of the nidus in the medullary spongy bone is not uncommon. It produces sclerosis of the entire cortex and shaft; the area can usually be spotted in the roentgenogram.

About as common is the case of the nidus located in the cortex of the bone. Dense layers of sclerotic bone enlarge the shaft throughout the area. The medullary cavity and the opposing cortex can be free of sclerotic change. The small lucent nidus can usually be found in the center of the sclerotic spindle. The locating of the nidus may often be extremely difficult.

The most unusual form of osteoid osteoma is one in a periosteal location, where the nidus elevates the periosteum. There may be a thin wafer of osseous tissue covering it. The adjacent cortex may show little or no sclerosis or it may become quite sclerotic. Only 2 cases of this type have been reported, according to the author, and both occurred in the area of the proximal phalanx. In the treatment of this type of the tumor, he states, the periosteal location of the osteoid osteoma must be recognized and roentgenograms of the area must include precise anteroposterior and lateral views.

The differential diagnosis from the roentgenogram in a case of osteoid osteoma must include syphilis of bone. Syphilitic dactylitis can produce diffuse sclerosis of the shaft and even a questionable nidus. Tuberculosis of the phalanx or metacarpal can appear similar to osteoid osteoma. There are forms of osteomyelitis and Brodie's abscess which give a picture quite like that of osteoid osteoma.

The treatment of osteoid osteoma is surgical extirpation of the nidus. This is also the only method by which a positive diagnosis can be made. Treatment by antibiotics has not been found to have any effect on the lesion. According to the author no treatment with the roentgen ray is known to have been tried. He thinks it might possibly alter the course of the lesion but there then would be the problem of proving what sort of entity was treated.

In this series, the microscopic examination showed a well demarcated nidus of osteoblastic tissue with osteoid intercellular substance. Around this area, the bone tended to be sclerotic.—*Ralph S. Bromer, M.D.*

Reich, Rudolph S., and Rosenberg, Norman J. Aseptic necrosis of bone in Caucasians with chronic hemolytic anaemia due to

combined sickling and thalassemia traits. *J. Bone & Joint Surg.*, Oct., 1953, *35-A*, 894–904.

The purpose of this paper is to describe the occurrence of aseptic necrosis of bone in Caucasians with chronic hemolytic anemia due to the combined presence of sickle-cell and Cooley's anemia. The authors wish to emphasize that these bone changes also occur in Negroes with classical sickle-cell anemia. In children these changes are indistinguishable both clinically and roentgenographically from Perthes' disease and in adults they must be differentiated from bone changes due to Gaucher's disease, metastatic neoplasms, caisson disease, Paget's disease or changes following fracture or dislocation of hip. Other less specific changes occur in these cases, but they are of the nature found in patients with any chronic hemolytic anemia.

The authors observed 3 patients in two Caucasian families in whom both the sickle-cell and Cooley's traits occurred simultaneously. Two of these patients had aseptic necrosis of the heads of the femurs and one had similar changes in the heads of the humeri. It is not uncommon to see aseptic necrosis of the femoral heads in Negro children or adults with sickle-cell anemia. The authors' patients and those reported elsewhere exhibited a chronic hemolytic anemia with sickling, microcytosis, decreased fragility, and target cells. They also had splenomegaly, jaundice and crises, all of which are common to sickle-cell anemia. Clinically the patients are indistinguishable from those with sickle-cell anemia, but genetically they do not have a true sickle-cell anemia; their siblings have shown either one or both traits or neither trait. In the families studied, 1 patient has had sickle-cell trait and the other has had Cooley's trait.

Genetically the patients reported in this paper did not have a true sickle-cell anemia but clinically they met all the criteria of sickle-cell anemia, except that the anemia was less severe. Hematological studies also met all the criteria of sickle-cell as well as those of Cooley's anemia and a decreased red blood cell fragility. Electrophoretic studies have shown that the structure of the hemoglobin found in sickle cells is different from that in normal red blood cells. Four distinctly different electrophoretic patterns have been described. Cells containing sickle-type hemoglobin are usually normal in shape in the circulating blood but quickly assume the sickle shape when they are exposed to an atmosphere of diminished oxygen tension. Blood containing sickled cells is more viscous and the cells themselves are more firm than normal cells.

The cases are reported in detail with roentgenographic illustrations. The authors comment that one patient developed aseptic necrosis of the head of the femur at a relatively early age. However, they point out that bone changes in both sickle-cell and Cooley's anemia have been reported during the first year of life. It is possible that the appearance of the aseptic necrosis of the head of the femur in their young patient may have been only a coincidence and that he may have had Perthes' disease of idiopathic origin. However, of 6 cases of combined sickle-cell trait and Cooley's trait of which they have knowledge, 3 show evidence of aseptic necrosis of the head of the femur and this seems more than just coincidence. Because this disease resembles sickle-cell anemia so closely, they are inclined to believe that the occurrence of aseptic necrosis in cases of sickle-cell has a similar pathology. —*Ralph S. Bromer, M.D.*

Ronald, James, Aseptic necrosis of bone in caisson disease. *Lancet*, Oct. 24, 1953, *2*, 855–856.

A case of aseptic necrosis of bone in caisson disease in a man aged sixty-two is described in detail. The patient has been employed as a diver for more than forty years. Weekly he was troubled with the "bends," pains in his joints, sick feeling in the abdomen, and air bubbles under the skin. He was admitted to the hospital with pain in his chest after a fall.

Roentgen examination revealed intramedullary calcification of the lower end of each femur, the upper end of each tibia, and the upper end of each humerus. The calcification started from the region of the epiphyseal line, extending into the shaft of the bone. The cortex was not involved.

The history of the disease and its care are reviewed. —*F. B. Markunas, M.D.*

Cohen, Jonathan, Brown, Kenneth A., and Grice, David S. Ewing's tumor of the talus (astragalus) simulating aseptic necrosis. *J. Bone & Joint Surg.*, Oct., 1953, *35-A*, 1008–1012.

The case reported in this paper is that of a boy, three years of age when first observed. Roentgenograms of the left foot revealed diffuse aseptic necrosis of the talus. Little change occurred in the two years following his first admission. At five years of age he developed a painless lump which grew rapidly over his left eye. The lump became painful and hyperesthetic, and physical examination revealed a large firm mass involving the right orbit and zygoma, with proptosis. He later developed an abdominal mass with many bone and pulmonary metastases. His course was rapidly retrogressive and when death occurred a complete autopsy was obtained. This revealed widespread dissemination of the tumor which had been diagnosed as a malignant lesion on the biopsy on admission.

The microscopical sections of the affected talus showed nearly complete involvement by the tumor. A few foci of calcification were seen in the necrotic tissue of the tumor growth. Some trabeculae were

overlaid with deposits of reactive bone which occasionally showed aseptic necrosis. The processes of tumor infiltration, necrosis and reaction in the talus were different from those in other bones.

While absolute proof is lacking that this talar lesion represents primary involvement by tumor with subsequent aseptic necrosis, the authors feel that the evidence favors this explanation rather than a diagnosis of metastatic malignancy in an area of aseptic necrosis.—*Ralph S. Bromer, M.D.*

Jacobson, George, and Adler, Denis C. An evaluation of lateral atlanto-axial displacement in injuries of the cervical spine. *Radiology*, Sept., 1953, *61*, 355–362.

Two hundred consecutive patients suspected of a cervical spine injury were studied. These patients were grouped into three categories according to location and type of injury. These categories were: (1) no evidence of fracture or dislocation, (2) fractures and/or dislocations of C-3 through C-7, and (3) fractures and/or dislocations of atlas and axis.

The asymmetry or overriding of the articular surfaces of the lateral masses of the atlas and axis, called offset, as seen in the anteroposterior projection was studied. It was found that the incidence of offset was 64.5 per cent in patients with fractures and/or dislocations of the atlas and axis, 13.5 per cent in patients with fractures and/or dislocations of C-3 through C-7, and 7.7 per cent in patients without other evidence of fracture or dislocation.

The types of offset recognized were: unilateral medial offset, unilateral lateral offset, bilateral offset, and bilateral spread. As might be expected, most of these offsets were found in cases of fracture and/or dislocation of the atlas and axis. It seemed that the larger amounts of offset, 3 mm. or greater, occurred more frequently with fractures and dislocations of the atlas and odontoid process.

Rotation and abduction of the head during examination can produce unilateral medial or bilateral offset but apparently has little more than slight influence on the amount of offset. Bilateral spread, however, can be produced only by fracture of the atlas, and it is highly probable that unilateral lateral offset is due to the same mechanism.

The authors conclude that whenever an offset is demonstrated on anteroposterior roentgenograms of the cervical spine, meticulous roentgen examinations of the atlas and axis are necessary to disclose an obscure fracture of these two vertebrae.—*Donald N. Dysart, M.D.*

Stewart, T. D. The age incidence of neural-arch defects in Alaskan natives, considered from the standpoint of etiology. *J. Bone & Joint Surg.*, Oct., 1953, *35-A*, 937–950.

The material from which the data for this paper were obtained consists of skeletons of Alaskan Eskimos and Aleuts preserved in the United States National Museum. The data are unique in that almost literally every second adult skeleton from north of the Yukon River shows one or more defective arches (the percentages vary regionally). Because of this high incidence, relatively small numbers of subadults suffice to establish the incidence in the lower age periods.

Acceptance of the fact that each half of the normal neural arch is usually intact at the outset of postnatal life, whereas it is often defective in adults (varying from about 5 to 50 per cent according to racial group), raises the question whether the incidence of defects increases at a regular rate during life. This question thus far has not been satisfactorily answered. Knowledge of the pattern of occurrence of arch defects is needed to distinguish among such causative factors as (1) fractures at birth through hyperflexion of the spine; (2) strain resulting from the assumption of upright posture in early childhood; (3) direct injury; (4) chronic trauma; and others. In view of the limited information available at present on the age incidence of neural arch defects, the author felt justified in presenting some unique data from archaeological sources. The significance of these data from the standpoint of etiology is discussed in the paper.

Tables are presented showing incidence of cases with arch defects by region and age period; age incidence of neural arch defects; incidence of cases with arch defects by region, state of maturity and sex; incidence of arch defects by segment and age period; distribution of six types of defective arch by segment and age period; incidence of single defective arch by segment and age period; and incidence of multiple defective arch by age period and segment. The anatomical types of defective arch are illustrated by photographs of the vertebrae.

From the study of the data collected, the author concludes that there is something peculiar to the Alaskan natives which causes them to acquire neural arch defects in the lumbar vertebrae much more frequently than other people. His new evidence of progression in incidence with age from about zero at birth makes the theory of hereditary cause of the defects untenable. Abandoning the theory of heredity, Stewart discusses the possibility of an explanation of the cause of the defects based on mechanics.

The Eskimos of Alaska, for their occupational activities, use a posture which is impossible of long endurance according to our way of thinking. Women at their usual occupations are seen standing straight legged and bent over in order to engage in hand operations at ground level. In this position the back and hip joints are hyperflexed while the lower extremities are nearly or fully extended. Most other people find the resultant extension of the hamstring muscles painful and hence kneel or sit down to any work. Eskimos do sit down to work, of course, but when they do so they often assume a similar position with

the lower extremities fully extended in front of them. The men also sit in this fashion and are compelled to do so when they are in their slender, skin-covered boats (kayaks). Although the women may not stay in this strange position very long at a time, the men at least cannot change position as long as they are in the kayak, and that can be for more than an hour. The effect of such posture on the low back is to reduce the normal lumbar lordosis and it is the very opposite of the effect produced in modern peoples by the wearing of heels. The fact that in the Eskimos, Stewart suggests, this extra stress is allowed to persist for long periods of time may be the distinctive feature in their way of life which leads to their very frequent acquisition of arch defects. This would not explain, however, cases of unilateral defect. As there is no motion in a sound arch, why, Stewart asks, should a complete cleavage develop on one side alone, since the stress brought to bear on the other side would be increased? Anomalous ossification may account for these exceptions.

Stewart concludes that the unusual incidence of arch defects in Eskimos is due to the combinations of unusual postural stress, a high accident rate due to travel over ice and rocky coastal terrains, and perhaps a somewhat more frequent occurrence of anomalous ossification. He remarks that only case histories of living subjects can give a better explanation.—*Ralph S. Bromer, M.D.*

Holland, H. W. Tabetic spinal arthropathy. *Proc. Roy. Soc. Med.*, Sept., 1953, *46*, 747–752.

Tabetic arthropathy was described by Charcot in 1868. Spinal arthropathy in tabes was first reported by Krönig. The majority of arthropathy joints are associated with tabes and syringomyelia but they also occur as a complication of cauda equina lesions, transverse myelitis, traumatic paraplegia, leprosy and diabetic polyneuritis.

Tabetic arthropathy of the spine is rarely recognized as a clinical and roentgenological entity because the spine is not routinely subjected to special study when a tabetic patient is examined. The roentgenological appearance may be very much more severe than the symptoms would suggest.

The usual location of spinal arthropathy in tabes is the lower dorsal and the lumbar portions of the spine. The disease is rarely found elsewhere. Localized and diffuse forms, either with bone atrophy or hypertrophy, may occur as in the peripheral arthropathies.

The hypertrophic bone results in a massive dense vertebra. This is associated with local bony outgrowths and narrowing of the intervertebral spaces. Bone destruction results in ragged and uneven vertebrae which is exaggerated by secondary new bone formation. Kyphoscoliosis is the commonest deformity and spondylolisthesis and pathological fractures may occur. In some cases paravertebral calcification similar to juxta-articular calcification in peripheral arthropathies is present. The author is uncertain whether or not diffuse osteoporosis, which has been described as a variety of arthropathy, represents a true tabetic process but believes it may be explained on the basis of disuse atrophy.

While the spinal condition may be symptomless, backache and root pains are common. In the differential diagnosis the following should be considered:

(1) Hypertrophic osteoarthritis.
(2) Tuberculous disease of the spine.
(3) Chronic low grade osteomyelitis.
(4) Paget's disease.

The author reports a series of 5 cases—3 males and 2 females ranging from forty-two to sixty-seven years of age.—*J. N. Ané, M.D.*

Lippmann, Robert K. Arthropathy due to adjacent inflammation. *J. Bone & Joint Surg.*, Oct., 1953, *35-A*, 967–979.

Lippmann states that his study, the results of which are reported in this paper, postulates that joint displacement due to adjacent inflammation is in no sense a specific affection of the atlanto-axial joint, but rather that it is a disturbance which develops at several skeletal locations. A few of the clinical characteristics of the phenomenon as observed in the literature and in his own casses are summarized as follows:

1. There is no typical time schedule or clinical pattern: Dislocation may be noted as early as twenty-four hours after simple tonsillectomy or as late as many years after onset of indolent cervical lymph node enlargement.

2. There appears to be no detectable relationship with the severity or intensity of the inflammatory process.

3. Of significance is the fact that the condition may constitute a response to either a primary neighboring focus or a remote focus draining into lymph nodes which lie close to the joint. Infections of the middle ear, osteomyelitis of the cranial vault, sinusitis, and root abscesses are examples of conditions which have produced arthropathy through the intermediary of the cervical lymph nodes draining into remote primary foci.

4. The condition generally starts suddenly during or shortly after the subsidence of the original focus: Usually the patient has the sensation that something in the neck has yielded. Premonitory symptoms are rare.

5. Pain may vary from mild discomfort to great agony: The most common complaint is of neck deformity.

6. A final noteworthy property of these lesions is their remarkable ability to heal firmly after reduction and immobilization, even when the causative inflammatory focus continues unabated.

There is no precise knowledge concerning the mechanism of the production of this type of arthropathy. The speed with which joint ligaments can weaken in response to neighboring inflammation may be readily demonstrated in animals. The author's laboratory studies on animals show the dramatic speed with which joint ligaments may weaken in response to a neighboring inflammation, long before skeletal decalcification reaches a level detectable by roentgenograms.

The atlanto-axial joint of the child is especially susceptible to a disturbance caused by adjacent inflammation. In children, the vulnerability of this joint as shown by the fact that it dislocates more readily than the lower cervical joints, is further augmented by the location of the joint in the center of potentially infected soft tissue—the pharynx and tonsils anteriorly and large clusters of cervical lymph nodes laterally. Unless subluxation is recognized and corrected in children, it can persist permanently in an adult spine.

The author calls attention to the fact that although spontaneous displacement of the atlas on the axis has been described in adults, an arthropathy which appears to be the adult equivalent of this lesion may be observed far more commonly at a lower cervical level. The usual sites of involvement in the adult are the third, fourth and fifth cervical interspaces, the descent in level being accounted for, most likely, by the relative descent of the cervical lymph nodes during growth. All of the cases reported in this paper were nontraumatic in origin and, in each instance, the lesion developed in association with neighboring soft tissue inflammation. Another more important difference is observed in the lower lesions in adults, namely, the independent susceptibility of the disc structure at the lower cervical levels. The almost invariable accompaniment of disc narrowing with subluxation and the occasional occurrence of disc destruction without subluxation at lower cervical levels suggest that the disc is even more vulnerable to neighboring inflammation than is the joint complex as a whole.

Lippmann regards the possible implication of this mechanism of disc involvement as of particular importance in the pathogenesis of the common disc lesion in the lumbar spine. He believes that considerable indirect evidence, both anatomical and clinical, indicates that the ligaments of the joints of the lower portion of the lumbar spine may weaken in response to nearby infection as do their cervical equivalents. Clinical experience shows the frequent association of low-back symptoms with primary inflammatory disturbances which involve the structures draining into these lymph nodes. The re-introduction of infection as a factor in the pathogenesis of these overtly mechanical conditions can account for a number of unexplained aspects of their development. It is difficult to conceive how postural change, the assumption of the orthograde instead of the quadruped posture, can materially alter the stress upon the cervical area. It is also difficult to reconcile how the selective, rapid, and premature disc collapse at certain specific levels occurs, while integrity is preserved at neighboring levels which are of practically identical structure and subject to equivalent stress. Equally puzzling, according to Lippmann, is the sudden precipitation of sciatica, as seen clinically, by the performance of a simple movement previously accomplished countless times without harmful consequence. He thinks that it would appear that in addition to trauma, to wear and tear, and to the aging process, the clinician must also consider the possibility of vulnerability due to adjacent inflammation, and he suggests prophylactic measures. During and after relevant illnesses, which include generalized lymphadenopathies, obstetrical experiences, gynecological and genitourinary infections and after surgery, low-back support and careful guidance of activity are indicated.—*Ralph S. Bromer, M.D.*

Blood and Lymph System

GVOZDANOVIĆ, V., and OBERHOFER, B. Mediastinal phlebography; a bilateral simultaneous injection technique. *Acta radiol.*, Oct., 1953, *40*, 395–407.

In the usual technique of opacification of the large veins of the mediastinum, 40–80 milliliters of a 70 per cent contrast medium is injected into one cubital vein. The authors recommend the injection of 20–25 ml. of 35 per cent contrast medium simultaneously in both cubital veins, a technique which they have been using for two years.

With the less concentrated contrast medium, which is cheaper, the danger of thrombosis is diminished.

The smaller amount may be injected easily in one to two seconds without greatly increasing venous pressure.

When only one arm is injected, the nonopacified blood from the opposite side mixes with opacified blood from the injected side in the superior vena cava, often simulating a thrombosis. The bilateral injection technique eliminates this difficulty.—*George Cooper, Jr., M.D.*

HORTON, R. E., and NANSON, E. M. Technique and value of aortography; report of a case of external iliac arterial graft. *Brit. M. J.*, Oct. 31, 1953, *2*, 969–971.

The authors describe in detail their technique of aortography. If the iliac vessels are to be visualized, injection is made opposite the third lumbar vertebra. For the renal vessels, it is made opposite the first lumbar vertebra and if the celiac axis and its branches are to be visualized, opposite the 12th dorsal vertebra. They have not encountered any serious ill effects in using their technique, though on

two occasions there was extravasation of the contrast medium into the periaortic tissues.

The authors feel that the greatest value of this technique is the outlining of a block in either the aorta or the iliac vessels resulting from embolus or thrombosis which would allow for surgical correction. They report on 4 cases. Two of their patients had complete occlusion of the aorta which was demonstrated on the aortogram and confirmed at necropsy. In one of the other cases obstruction of the whole external iliac vessel was demonstrated and an aorta graft substituted for it. An excellent result was obtained and a postoperative aortogram showed the graft to be in position and of normal caliber.

The authors pass over the subject of aortography in relation to renal disease with one short paragraph and have apparently had little experience with it.—*Lawrence A. Davis, M.D.*

Ivy, Robert, E., and Howard, Fred H. Sickle-cell anemia with unusual bone changes. *J. Pediat.*, Sept., 1953, *43*, 312–315.

The authors report a case of sickle cell anemia in a one year old colored infant who presented unusual swelling of the hands and feet which developed thirteen days following initiation of treatment.

Roentgenograms of the hands revealed areas of radiolucency in the distal metaphysis of the radius and ulna, as well as in the metacarpals and phalanges. These were both subperiosteal and intramedullary in type. There was also associated expansion of the bony structures. Roentgenograms of the rest of the body were negative. The patient was followed for six months. At the end of two and one-half months there was complete return to normal in the bony pattern of the hands. There was complete absence of symptoms at six months.

A short discussion is given concerning the findings with no definite conclusion for the pathogenesis other than a peculiar manifestation of this disease.

Roentgenograms showing the changes are reproduced in the paper.—*Leslie L. Lemak, M.D.*

Shefts, Lawrence, M., Terrill, Arthur A., and Swindell, Herbert. Scalene node biopsy. *Am. Rev. Tuberc.*, Oct., 1953, *68*, 505–522.

A series of scalene node biopsies is presented primarily as an additional report to further evaluate this type biopsy in intrathoracic conditions. Complications were limited to involvement of the thoracic duct, which occurred in 3 cases. A temporary Horner's syndrome was produced only once. Although complications were few, this operation is not recommended as an office procedure.

The study consisted of 205 scalene node dissections, including 17 bilateral dissections, in 187 patients not otherwise diagnosed. In 67 patients the biopsy proved positive (35.8 per cent). Boeck's sarcoid was present in 38; bronchogenic carcinoma in 13 (9 undifferentiated, 4 adenocarcinoma); tuberculosis in 8; lymphosarcoma in 2; Hodgkin's disease in 2; histoplasmosis in 1; and metastasis to the lung in 3.

The side of the neck homolateral to the side of principal intrathoracic involvement is chosen for exploration. Where enlargement of the mediastinum is equal bilaterally, it is suggested that the left side be explored. Actually, little difference, statistically, exists between the right and left scalene nodes in terms of positive findings.

Boeck's sarcoid was the most common diagnosis in the series and it was assumed that the mediastinal nodes were enlarged, although not evident on chest roentgenograms, since all scalene nodes found positive were enlarged. In bronchogenic carcinoma scalene node biopsies, if positive, not only indicated extension of the process but established the exact cell type. The 8 cases of tuberculosis had negative sputum examinations and there was no evidence of parenchymal involvement on roentgenographic studies.

The scalene node biopsy was the only positive method of diagnosis in the case of lymphoma.

In suspected cases of fungus infections, cultures of the nodes were more important than the histologic study.

The importance of scalene node biopsies in metastatic disease of the lungs is obvious in that the microscopic type of metastasis may be of aid in finding the primary site.

Scalene node biopsy was thought to be indicated in all cases of proved bronchogenic carcinoma to determine if the carcinoma has extended beyond the thorax, and in all cases of suspected bronchogenic carcinoma.—*W. T. Edenfield, M.D.*

General

Latham, W. J. Hydatid disease. Part II. Hydatid disease in the renal tract, bone, muscles, and nervous sytem. *J. Fac. Radiologists*, Oct., 1953, *5*, 83–95.

Renal Tract. It is probable that the vast majority of renal hydatids are primary and blood-borne. They constitute about 2 per cent of all hydatids. The air in the "air-cap" seen in liver and lung cysts is replaced in renal cysts by the opaque medium used in pyelography. Otherwise, the behavior of hydatid cysts is much the same in the kidney as elsewhere. A hydatid cyst, whenever its location permits, expands in the direction of least resistance. Obviously, in the kidneys such direction would be anterior. These cysts may distort the calyces and present a roentgen appearance similar to that of a simple serous cyst, or it may stretch, distort or obliterate a group of calyces, similar to a neoplasm. The cyst may

become calcified, but instead of always being rounded in may be irregular and so may be mistaken for a calcifying new growth or a renal tubercle.

While closed, the hydatid cyst is silent, but when the contents break through the cyst wall and the adventitia, renal colic, hematuria, dysuria and the passage of daughter cysts and hydatid debris result. When the adventitia alone is broken, contrast medium injected through a ureteral catheter spreads around the cyst in a way comparable with barium mixture spreading around the fecal contents of a colonic diverticulum, giving the so-called "wine-glass" shadow. If the cyst wall also is broken, the injected opaque medium can enter and infiltrate around daughter cysts, forming negative shadows. If all the cyst content has been evacuated at the time of rupture it may be difficult to distinguish between renal tubercle, cavernous tubercle, or other type of cavity.

Bone. In hydatid disease of bone, symptoms may be absent for a long time, or until pathological fracture or sepsis appears. Such lesions probably constitute less than 2 per cent of the total hydatid incidence in the body, and they are most common in dorsal spine, pelvis and sacrum, then in the humerus, femur and tibia. Bone hydatidosis in its very earliest stage consists of small exogenous vesicles expanding and destroying the bone medulla, producing round, cyst-like spaces. In Stage 2, infection is added, producing osteitic reaction with periostitis. As long as the skin remains intact, it is unlikely that appreciable infection will be present. In Stage 3, ossifluent abscess or pseudo-abscess appears, which Latham regards as pathognomonic of vertebral osteohydatidosis. Such an abscess may reveal itself as a soft tissue swelling. When situated in the spine, there is no evidence of narrowing of the adjacent vertebral disc space; there are small rounded, cyst-like areas of destruction in the anterior part of the body of the adjacent vertebra; there may be attenuation or destruction of the adjacent vertebral pedicle and/or possibly the transverse process. Paraplegia may result. In Stage 4, the bone architecture has disappeared, and the entire bone may be lost beyond recognition. A hemipelvis or a whole femur replaced by a meaningless jumble of calcareous bubbles is the characteristic of this stage. In the early stages one must distinguish between hydatidosis and osteoclastoma. In later stages, solitary myeloma, osteolytic sarcoma and osteitis fibrosa cystica are to be considered in differential diagnosis. Radical surgery is the best treatment. Roentgen therapy is of no value.

Muscles and Soft Tissues. The incidence here may vary between 0.8 and 5 per cent. Involvement of the muscles of the thigh is comparatively common. Roentgen examination is not of much value except to distinguish a hydatid cyst from a lipoma, the latter being more radiolucent.

Central Nervous System. The Hydatid Register indicates an incidence of brain hydatids just under 1 per cent of the total. Brain cysts do not form na adventitia but they frequently calcify. By cerebral angiography the hydatid mass in the brain is found to be without a blood supply. Other than this, hydatids in the brain reveal themselves in the same way as any other space-occupying lesion.—*Samuel G. Henderson, M.D.*

Turner, John W. Observations on neoplastic spread; some radiologic aspects of the problem. *New England J. Med.*, Sept. 24, 1953, *249*, 507–514.

In this interesting article the author reviews his extensive experience with the roentgen diagnostic aspects of neoplastic spread. The early recognition of metastatic cancer increases the benefits of the improved and newer modes of therapy. The practical value of therapeutic measures is shown to compare favorably with that of treatment offered patients suffering from severe chronic non-neoplastic diseases.

As late metastatic foci in organs and systems remote from the primary sites often present difficult diagnostic problems, the author emphasizes that a program of roentgen survey should be carried out in all suspected patients. This should include standard views of the skull, spine, ribs, pelvis, and the proximal portions of each femur and the lungs. With atypical symptoms the evaluation of possible soft tissue metastatic foci may require myelography, angiography, and genitourinary and gastrointestinal studies. Examination of the sputum for tumor cells is advocated in the search for metastatic as well as primary neoplastic disease in the lungs. The author believes that the failure of roentgen findings to parallel the autopsy incidence of pericardial and cardiac invasion indicates a need for more accurate evaluation of this type of metastatic disease by other methods.

The author divides his material into three general groups, *i.e.*, skeletal metastases, intrathoracic involvement and soft tissue changes. Many interesting observations are included in each group. In his experience the relatively early appearance of widespread metastatic disease in cancer of the lungs, stomach and pancreas coincides with the disappointing results from radical surgery in these lesions. On the other hand, the tendency of cancer of the larynx, colon, rectum, uterine fundus, and to a lesser degree, of the uterine cervix to remain anatomically localized longer agrees with the higher five year survivals in these conditions.

The author lists three criteria for palliative resection of solitary metastatic lesions. (1) the primary growth could be controlled; (2) the primary lesion should be of a well differentiated tissue type; (3) the time interval from the control of the primary cancer to the recognition of a metastatic focus should be greater than one year.—*T. D. Allison, M.D.*

Grossiord, André, Bernard, Jacques, and Marteau, René. Myopathie et séquelles de poliomyélite; intérêt des radiographies musculaires. (Myopathy and sequelae of poliomyelitis; role of muscle roentgenography.) *Presse méd.*, Oct. 21, 1953, *61*, 1353–1354.

The coexistence of myopathy and poliomyelitic sequelae in the same individual has been described several times. In some cases, poliomyelitis supervened in the course of myopathy. In the present case, as in others, poliomyelitis of infancy preceded the myopathy. The authors feel this is coincidental.

The roentgenographic features of interest are as follows: Normal muscle in the young is characterized by homogeneity except for some vein shadows. This homogeneity is lost as the individual becomes older, and is replaced by thick irregular striae. In myopathy, there are various changes but fairly consistently there is a fine striation. In poliomyelitis there are, fairly frequently, clear elongated spaces in the direction of the intermuscular aponeuroses. In addition, the subcutaneous tissues may be thickened.—*M. L. Sussman, M.D.*

Harrison, Mary T., and Mercer, Robert D. Vitamin A intoxication. *Cleveland Clin. Quart.*, Oct., 1953, *20*, 424–429.

The authors discuss the criteria for the establishment of the diagnosis of vitamin A intoxication and list the reported clinical manifestations.

A case of a twenty-eight month old boy with a history of excessive vitamin A intake is presented. The clinical features of cheilosis, rash, pruritus, irritability, hot, tender swellings along both ulnar shafts, and over both fifth metatarsal bones are described.

Blood ascorbic acid level was reported as "0.26 per hundred cc." A semiquantitative test revealed the blood vitamin A level to be elevated.

Cortical hyperostoses of both ulnae and similar changes in the right fifth and the left fourth and fifth metatarsal bones were demonstrated roentgenographically. Other roentgenographic changes in the ulnae were believed to be indicative of the additional presence of healing rickets or scurvy.

Improvement was noted within several days after an adequate diet and daily doses of ascorbic acid had been instituted. Only minimal periosteal changes in the metatarsal bones were demonstrable four months after admission.

A six month old sibling who received a similar dosage of vitamin A, but for a relatively much shorter period of time, did not show an elevated vitamin A blood level, nor had similar bone changes demonstrable by roentgen studies.

The differentiating features of infantile cortical hyperostosis and hypervitaminosis A are discussed. —*J. A. Ward, M.D.*

RADIATION THERAPY

McCormick, Norman A. A report on the survival of the patients treated for cancer from 1935 to 1947 inclusive. *Canad. M.A.J.*, Sept., 1953, *69*, 288–293.

During this period 4,523 patients were treated and 99.7 per cent have been followed; 1,204 survived five years and 906 are now alive and free of evidence of malignant disease from five to seventeen years after treatment. It is anticipated that more than 50 per cent of the patients being seen and treated now may be expected to survive five years. Exclusive of cancer of the skin, of patients treated in 1935, 17 per cent survived five years; 1936, 29 per cent; 1947, 45 per cent. Patients with carcinoma of the skin carried the best prognosis: 77 per cent survived five years.

Carcinoma of the breast received varying forms of treatment. In 144 cases roentgen therapy prior to surgery produced a 58 per cent five year survival and 70 cases treated with surgery and then referred for roentgen therapy had 46 per cent five year survival. Routine treatment now consists of preoperative roentgen therapy in Stages I, II and III and postoperative roentgen therapy in Stages II and III.

There were 274 cases of carcinoma of the cervix, 44 per cent of which survived five years. The first five years 30 per cent survived and during the period of 1945 to 1947, 60 per cent survived.

Carcinoma of the lip treated by irradiation had a survival rate of 60 per cent; 19 per cent died of intercurrent disease and 1 per cent died of the cancer.

Fifty-six cases of carcinoma of the rectum had 30 per cent five year survival. Some cases considered inoperable received marked benefit from roentgen therapy.

None of the cases of carcinoma of the stomach survived five years and most of the cases referred were considered inoperable.

In carcinoma of the bladder 98 cases treated with roentgen therapy, followed with radon implantation, had a five year survival rate of 21 per cent.

Of 76 cases of carcinoma of the fundus of the uterus treated with radium, followed by surgery six weeks later, 51 per cent survived.

In bronchogenic carcinoma 3 cases were alive and well five years after treatment with irradiation. This gives promise of some hope in treatment of this disease.

In carcinoma of the ovary, 27 per cent of 55 cases survived five years.

Of all cases seen in this clinic, 38 per cent were suitable only for palliation when first seen. The program of education being carried on now should reduce this figure.—*Neal F. Yeomans, M.D.*

Brown, W. M. Court, and Mahler, R. F. The x-ray dose-body size relationship in radiation sickness. *Science*, Sept. 4, 1953, *118*, 271–272.

Since 1949 the Medical Research Council has been studying the general effects of a single therapeutic dose of roentgen rays upon patients. An essential part of this investigation has been the study of the pattern of symptoms, which may be produced by doses of roentgen rays within the range of integral dose (total energy absorption) of 2.5 to 5 megagram-roentgens.

There are three essential phases to a symptom pattern: the latent period, the period of acute symptoms, and the recovery period. Of these only the first two are discussed. The latent period is that time interval between the initial roentgen-ray dose and the onset of symptoms, such as nausea, vomiting, etc. The acute symptom phase is that phase between the onset of symptoms and symptom improvement. Controlled studies were done by exposing a number of patients to sham irradiation to make sure that the symptoms were not produced by psychological conditions. There is a close relationship between the latent period and the acute symptom period—the latent period being inversely proportional to the acute symptom period.

Twenty patients, all early cases of ankylosing spondylitis, were subjected to a single dose of roentgen rays. Previous studies led the authors to believe that the length of the latent period was influenced by the integral dose given. These studies proved that there was no significant correlation between the two, unless the size of the patient was taken into consideration. When the ratio of integral dose to the total body surface area was compared with the length of the latent period, no significant correlation could be reached, but when the ratio of the integral dose to the body weight or body surface was taken into consideration and compared with the length of the latent period, a significant correlation was obtained.

These findings indicate that if the length of the latent period can be regarded as an indication of one aspect of biological response to irradiation, then its length is not only a function of the dose of radiation but also of the size of the individual irradiated.—*John Watts, M.D.*

Krabbenhoft, K. L., and Leucutia, T. Subdeltoid bursitis. *J. Michigan M. Soc.*, Sept., 1953, *52*, 986–988; also 996.

Subdeltoid bursitis is a term widely used for an entity which has been shown to be due to an inflammatory process involving the supraspinatus tendon. Degeneration in the relatively avascular tendon is followed by calcification in many cases.

Clinically the cases are divided into acute (less than 1 week), subacute (1 week to 2 months) and chronic. The acute cases may have excruciating pain; limitation of active abduction and internal rotation; tenderness over the greater tuberosity of the humerus; and local swelling. Subacute and chronic cases may give a history of intermittent pain and more restriction of motion. Severe chronic cases may show marked muscular contraction and joint adhesions.

Roentgenographically calcium may be demonstrated in the region of the supraspinatus tendon (in half the cases in one series). The roentgenograms should be taken in internal and external rotation. Size of the calcium deposit bears no relation to the duration nor severity of the disease and is of no prognostic value.

Several methods of therapy have been used but roentgen therapy has been shown to be effective and conservative. In evaluating therapy, however, it should be noted that spontaneous recovery and absorption of calcium can occur (in 12 per cent of one series and in as short a period as 14 days). Various authors report up to 94 per cent improvement or cures in acute cases and from 30 to 50 per cent improvement or cures in chronic cases. In general, response is more favorable early in the disease and in those patients with demonstrable calcification.

Over 2,400 cases of subdeltoid bursitis have been treated at Harper Hospital, Detroit. The great majority have been seen in the past eight years, suggesting an increase in incidence. The authors' technique is to give 100 to 125 r in air to the anterior aspect of the shoulder at each of 4 treatments, the first 2 at weekly intervals and the second 2 at bi-weekly intervals. The factors are: 200 kv., filter of 1 mm. Cu and 1 mm. Al and 50 cm. focus skin distance. Frequently the cervical spine is also treated and occasionally 1 or 2 more additional treatments are given if the initial series does not give complete relief.—*Henry J. Klos, M.D.*

Finzi, N. S. A new method of treatment for arthritis. *Brit. J. Radiol.*, Sept., 1953, *26*, 488–489.

The author states that his purpose in presenting this communication is to attract the attention of radiotherapists to a very valuable method of treatment.

He cites the case history of a woman who was treated by him in March, 1937. This patient suffered from arthritis of the hands of over twenty years' duration and, when examined prior to treatment, she had marked bilateral ulnar deviation and considerable swelling of all the small joints of the hands with severe pain in the neck. She was given 130 r in air over the neck posteriorly through a 15 by 15 cm. field with the following factors: 210 kv., Thoraeus filter, 1.9 mm. Cu half-value layer, and 38 cm. skin focus distance. There was immediate relief of pain and, therefore, the treatment was repeated, always only over the neck, at weekly intervals for twelve weeks, the dose being gradually reduced to 100 r in air. By this time there was also a marked regression of the swelling of the hands and the movements in the small joints of the hands became relatively free.

This improvement continued for another three months and there were no signs of recurrence two years later when the patient died of pneumonia.

Stimulated by this result, the author continued to use roentgen therapy in private practice in a number of similar cases and, on the basis of experience gained, he later extended it to other areas. Thus, in arthritis of the lower limbs he treated the lumbar region and in cases of arthritis of the knees he irradiated both, locally and over the lumbar region.

During the course of time some modifications were also made in the technique of irradiation. At the present, in arthritis of the upper limbs an initial surface dose of 75 to 80 r is given to the back of the neck and this is gradually reduced to 55 or 60 r. Concomitantly a dose of 60 r gradually reduced to 45 r is given to the hands and a correspondingly greater dose to obtain the same lesion dose of 60 to 45 r to the elbows and shoulders, only the affected joints being irradiated. In arthritis of the lower limbs, the dose over the lumbosarcal region (from about the 12th dorsal to the 3rd lumbar) starts with 80 to 100 r, depending on the size of the patient, and is gradually reduced to 65 or 70 r. When the joints are treated as well, the lesion dose should be 60 r, gradually reduced to 45 or 50 r. The factors are the same as described above, except that in irradiating the lumbosacral region the skin focus distance is increased to 50 cm. and the field size to 12 by 20 cm. or 15 by 20 cm.

The total dose of a course of treatments rarely exceeds 800 to 900 r over twelve to sixteen weeks which is considerably below the erythema dose level. In some cases one or two additional courses may be necessary but, even so, no skin changes are observed. The effect on the ovaries may likewise be disregarded in most instances since women with arthritis are usually past the menopausal age.

In general, the author obtained such satisfactory results that he hopes that other radiotherapists will continue the investigation along similar lines.—*T. Leucutia, M.D.*

Lederman, M. Radiotherapy of cancer of the penis. *Brit. J. Urol.*, Sept., 1953, *25*, 224–232.

The author reports 61 cases of cancer of the penis treated at The Royal Cancer Hospital in London. The majority of the cases had squamous cell carcinoma. Twenty-seven tumors arose from the glans and 31 from the prepuce, frenum, or coronal sulcus.

He states that the following can be accepted as contraindications to radiation therapy: (1) the elderly patient to whom loss of the penis may be of no great moment; (2) infiltrating or destructive lesions (3) the presence of deep invasion of the corpora or glans.

A dorsal slit or circumcision is advised as a preliminary step to radiation therapy since nearly all the patients coming for treatment are uncircumcised and most of them have a phimosis.

The policy generally adopted has been to use radiation therapy wherever possible, reserving surgery for cases considered unsuitable for irradiation or for failures following such treatment. Thirteen patients have had an immediate amputation of the penis with routine postoperative irradiation to the inguinal lymph node areas. Of the remaining 48 patients, who were treated initially by radiation therapy, 13 required subsequent amputation of the penis, 2 block dissection and 4 both amputation of the penis and block dissection.

A compilation of the final results revealed that of the 48 patients treated by radiation therapy 44 were followed-up for five years or more, and of these 13, or 30 per cent, survived without the help of surgery, but by operating on 19 "failed radiotherapy" cases, 11 additional patients were salvaged and the survival rate thereby rose to 24 out of 44, or 54 per cent. The real value of radiation therapy is shown by the fact that over half the total number of the survivors (13 out of 24) retained the penis.

The author concludes that neither surgery nor radiation therapy, when used exclusively, gives particularly good results. If the patient is to be given the best chance of saving his penis as well as his life, then a combination of both methods of treatment should be used. Generally, the young patient and the early lesion are treated by radiation therapy first, surgery being held in reserve in the event of failure. The elderly patient or the more advanced tumor is submitted to surgical treatment first if feasible. Surgery is the treatment of choice for the operable inguinal lymph node metastases.—*Ralph F. Niehaus, M.D.*

Brintnall, E. S. Surgical treatment of post-irradiation rectal stricture and rectovaginal and rectovaginal fistula. *A.M.A. Arch. Surg.*, Sept., 1953, *67*, 346–352.

While radiation therapy continues to be the mainstay in treatment of carcinoma of the cervix, certain complications of this treatment are amenable to surgical treatment. Rectal stricture and rectovaginal fistula occur in less than 2 per cent of the cases treated with irradiation. The author reports on 12 cases which were seen during two years at the University Hospital, Iowa City, Iowa.

Nine cases had rectovaginal fistulas occurring one to fifteen months after irradiation (average 11 months). Two also had vesicovaginal fistulas. Three cases had rectosigmoid strictures occurring one month, fifteen months and nine years after irradiation.

Results of treatment were as follows: One patient died in two months. One patient had a recurrence of a rectovaginal fistula. Two are well but partially incontinent of feces after pull-through (Hochenegg) procedures. Of 8 cases who obtained a good result, 6

had resection and transanal anastomosis and 2 had anterior resections and anastomosis. One patient with a vasicovaginal fistula had an ileal bladder constructed which functioned well.—*Neal F. Yeomans, M.D.*

Dobbie, B. M. Willmott. Vaginal recurrences in carcinoma of the body of the uterus and their prevention by radium therapy. *J. Obst. & Gynaec. Brit. Emp.*, Oct., 1953, *60*, 702–705.

The work described was suggested by the clinical observation that vaginal vault recurrences are rather common when carcinoma of the body of the uterus is treated by hysterectomy alone, but not when radium therapy is used instead of surgery. The term "recurrence" is here used to include all scar recurrences and typical metastases.

A series of 228 cases of adenocarcinoma of the body of the uterus, all apparently well three months after total abdominal hysterectomy, has been followed up for five to fifteen years. Of 64 cases treated by hysterectomy alone, 7 (11 per cent) and of 80 cases treated by roentgen therapy after hysterectomy, 8 (10 per cent) developed vaginal recurrence. Of 84 patients in whom hysterectomy was followed by vaginal radium, only 2 (2.4 per cent) had recurrence in the vagina, neither in the treated area. The method of applying vaginal radium is described.

Nine of the recurrences were in the vaginal vault. Only 2 were suburethral. It seems that implants in the latter site do not tend to appear until long after removal of the primary lesion. Four of the recurrences appeared later than the fifth anniversary of the hysterectomy. Of the 17 cases having vaginal recurrence, 5 were well five years later, and 1 is well after two years. The five year survival rate without recurrence is the same in the three groups.—*Eugene J. McDonald, M.D.*

RADIOSOTOPES

Neumayr, A., Brichta, G., and Vetter, H. Ueber die Messung der peripheren Durchblutung durch Bestimmung der Gewebsclearance von radioaktivem Jod. (On the measurement of peripheral blood circulation by determination of the tissue clearance with radioactive iodine.) *Wien. klin. Wchnschr.*, Oct. 23, 1953, *65*, 892–896.

Following Kety's method of studying tissue clearances, the authors injected between 2 and 10 microcuries of radioactive iodine intramuscularly at a standardized depth of the patient's leg. The clearance rate of the isotope was then measured with a Geiger counter placed at a distance of 10 cm. from the skin. Patients were brought to the measuring room one-half hour before the injection and the room was kept at a constant temperature of 22° C. The coefficient of clearance, k, was either obtained from the exponential clearance curve itself or, more conveniently, from its simplified form k $(0.693/HCT)$, where HCT is the half clearance time, *i.e.*, the time which elapses from a given starting point until only one-half of the activity is present.

Studies were made on 30 patients, 13 of whom were normal as far as their blood vessels were concerned.

The authors come to the conclusion that the tissue clearance method with radioactive isotopes is not satisfactory for the diagnosis of peripheral arterial circulatory disturbances, since the clearance rate depends upon many factors and not only upon the blood flow through the capillaries. Among these factors the capillary permeability is of definite importance. Hyaluronidase, for example, given intra-arterially produces an increase in permeability with a flow of proteins into the tissues and a subsequent retardation of clearance. In addition, the technical procedures of injecting the same quantity of the isotope into the same tissue layer with the same number of capillaries within the deposit area are necessarily difficult and the results doubtful. Reproduction of results is unsatisfactory. Only in the acute experiment, which permits keeping experimental conditions constant, could the change in the exponential decrease of the tissue clearance be evaluated and the effect of drugs upon metabolism be determined. Acetylcholine, given intra-arterially, increased the clearance rate while regitin had no effect.—*Otto Glasser, Ph.D.*

Rugh, Roberts. Thiouracil modification of effect of radioiodine (I^{131}) on the thyroid. *Radiology*, Sept., 1953, *61*, 391–300.

The methods employed and the results of the author's studies to determine whether the histologic reaction of the intact thyroid to injected radioiodine might be altered by pretreatment of the animal with thiouracil are presented.

Four groups of 12 Japanese fire salamanders were used in this study—a control group, a group treated with thiouracil, a group treated with radioiodine, and a fourth group treated with thiouracil and then radioiodine. The group given thiouracil received 10 mg. intraperitoneally on the first, fourth, sixth, and twentieth days. Twenty-five microcuries of radioiodine in the form of carrier-free sodium iodide were given the appropriate animals, with that group that had been pretreated with thiouracil receiving it on the twenty-second experimental day.

Three animals from each group were sacrificed at intervals of one week, one month, two months, and seven months, with preservation and histologic examination of the thyroid and anterior pituitary glands. From this it was found that the thiouracil had a transient antithyroid effect, which began between the first and fourth week, and had completely

disappeared by the eighth. The radioiodine, alone, caused progressive destruction of the thyroid after an initial delay of over a week, to the extent that there could be no secretory or metabolic function after two months, and produced degenerative changes in the anterior pituitary gland. In the thiouracil plus radioiodine group, the thyroid showed a variable response, but there was protection of the gland in some specimens, even after seven months. Studies of the anterior pituitary gland showed that although it does not respond as rapidly, cytological changes paralleling those in the thyroid do occur.

A short discussion of other workers' conclusions from the use of thyroid-stimulating and antithyroid substances on lower animals and mammals is given.

It is the author's contention that, although the thiouracil does not prevent the passage of radioiodine through the thyroid gland, it does prevent it from staying there long enough to cause radiation damage to the cells. After the transient effect of the thiouracil wears off, damage by the relatively slower radioiodine will occur. The question arises as to whether a time-dose relationship could not be established, with post-treatment with thiouracil, in order to afford greater protection. This is being investigated.—*Charles L. Stevenson, M.D.*

Lang, Norbert, and Nöller, Hans-Günter. Relationen der Radiojod-Ausscheidungsgeschwindigkeit bei Gesunden und Hyperthyreosen. (Relationships of excretion rates of radioiodine in normals and hyperthyroids.) *Klin. Wchnschr.*, Sept. 15, 1953, *31*, 846–848.

Following oral application of from 10 to 50 microcuries of iodine-131 the authors examined six single portions of urine collected after 2, 4, 6, 12, 24 and 48 hours. Activities of these samples are measured either with a beta-window counter or a dipping counter. Results are expressed in three groups, A, B and C. A represents the ratio of the activity of the total urine of the first two hour period to the activity of the urine of the second two hour period; B is the ratio of activities of the first and the third two hour periods, and C is the ratio of the activities of the first and the second six hour periods.

The results together with the twenty-four hour rate are presented in a rather instructive "tridimensional" graphic system.

Based upon observations in 32 normals, 15 clinically proved hyperthyroid cases and 76 borderline cases, the authors come to the conclusion that their method of registering excretion rates of iodine-131 is more reliable and agrees more closely with clinical observations than the conventional twenty-four or forty-eight hour excretion tests.—*Otto Glasser, Ph.D.*

Blanco Soler, C., Salgado Alba, A., and Blanco Soler y Ros, C. Consideraciones sobre 40 casos de hipertiroidismo tratados con yodo radiactivo. (Considerations on 40 cases of hyperthyroidism treated with radioactive iodine.) *Semana méd.*, Sept. 3, 1953, *103*, 325–335.

The authors consider the administration of radioactive iodine as the treatment of choice in hyperthyroidism; they state that coincidence of pregnancy or lactation is the only absolute contraindication.

A total of 40 cases was treated: 28 diffuse goiters, 8 nodular goiters and 4 cases without visible thyroid enlargement. The total doses administered ranged from 3 to 8 millicuries, mostly in the form of one or two applications. The weight gain and the increase in serum cholesterol closely paralleled the favorable clinical remissions in all cases. In 25 patients (62 per cent) a cure was obtained; 15 other patients (37 per cent) experienced a marked remission of their symptoms. In 9 cases there was exacerbation of hyperthyroidism after administration of radioactive iodine; antithyroid drugs were used in these cases without success, but clinical improvement followed after fifteen to sixty days. One patient developed hypothyroidism which was easily controlled with thyroid extract. Seven patients presented a recurrence; in the opinion of the authors, recurrences were due to the insufficient initial dosage which they estimate should never be less than 5 millicuries.—*F. Comas, M.D.*

Neil, Russell, H., Costolow, William E., and Meland, Orville N. Design and construction of a simple applicator for 1,000 curies of cobalt 60. *Radiology*, Sept., 1953, *61*, 408–410.

Early in 1948, it was considered possible to design a Co^{60} applicator which would be simpler than the mercury plug for the 4 gram radium bomb as used by the authors. The construction and use of this container is described.

The applicator is essentially a 20 inch diameter lead cylinder with hemispherical ends, using about 3,000 pounds of lead within its shell. The source of 1,080 curies, 181.74 grams of cobalt, occupying 20.42 cc. of space, is contained within a tube of 2 inch diameter, extending into the cylinder from one end. At the bottom of this tube the Co^{60} source is in safe position. When moved back to about the midpoint of the length of the tube, it is adjacent to the two portals, which extend radially from the long axis of the cylinder on opposite sides; one of these ordinarily being stopped up. Application is through a heavy beam-limiting lead cone, which may be moved inward or outward within the tapering portal. Controls are operated through 220 volt, 3 phase motors, and all operations can be completed by hand in case of power failure. Only readily available stock parts were used in assembling the controls, and no pre-

cision machine work was needed in making either the container or its controls. The applicator has been in constant use, without mechanical difficulties, since April 23, 1952.

The container is also used for shipping, and the simplicity makes up for the heavy weight. Shipping weight is 4,400 pounds.—*Lynne J. Taylor, M.D.*

Batley, Frank. Cobalt^{60} teletherapy; some principles and observations. *J. Canad. A. Radiologists*, Sept., 1953, *4*, 66–69.

The author presents his observations on the use of cobalt teletherapy at the Ontario Cancer Treatment and Research Foundation. With cobalt teletherapy, the maximum dose is obtained at a depth of 6 mm. so that greater doses can be tolerated by the skin than with conventional deep roentgen therapy units. This, the author states, will permit the delivery of much greater tumor doses and thus, it is hoped, will increase the number of treatment cures. He foresees a possible change in the rationale of palliative treatment, for with greater skin tolerance better results can be expected.

Study of cobalt teletherapy has shown a definite advantage in the treatment with small fields. Scatter is considerable with large fields in conventional deep roentgen therapy so that reduction in field size appreciably reduces the percentage depth dose. This is not true with cobalt since the percentage depth dose is not significantly augmented by scatter.

Bone necrosis is also less of a hazard since the tissue absorption of radiation is less with cobalt than that of deep roentgen therapy.

Some of the disadvantages encountered by the author were: (1) Limitation to rectangular treatment portals. In order to alter the portals shape, 3 cm. of lead is needed to reduce the incident beam by 90 per cent. Altering the portal shape thus becomes cumbersome. (2) Construction of the unit makes some treatment angles awkward or impossible. This can be partially obviated by using greater focal skin distances.

The author compares the use of cobalt teletherapy with the use of an expensive camera. Each needs more specialized equipment than its less expensive counterpart. The requisites with a cobalt unit are beam direction devices, a mould room, and a physicist with his instrumentarium.—*Geno DiBagno, M.D.*

MISCELLANEOUS

Gund, K., and Berger, H. Die 15-MeV-Elektronenschleuder für medizinische Anwendung der Siemens-Reiniger-Werke. (The 15 mev. betatron for medical application built by the Siemens-Reiniger-Werke.) *Strahlentherapie*, 1953, *92*, 489–505.

The late Dr. Gund (who passed away on May 31, 1953) was in charge of the Betatron Laboratory of the Siemens-Reiniger-Werke, Erlangen, Germany, and was chiefly responsible for the construction of the several betatron units used for medical application in that country. As is known, two 6 mev. units were installed in 1946, one at the Second Institute of Physics of the University of Göttingen and the other at the Medical Clinic of the University of Erlangen (see abstracts this Journal, 1952, *67*, 328–329 and 694–695). Both of these units operated satisfactorily and enabled the users to gain considerable experience in treating various lesions near the surface of the body. Recently, a 15 mev. model has been constructed for medical application and a 25 mev. and a 35 mev. model for physical and biological investigations (abstractor's note).

In the present article the 15 mev. model is presented in extenso, numerous photographs and diagrams being used for illustration. The following items are discussed: (1) physical properties of betatron radiation; (2) need for a medical betatron; the technical task; (4) injector and vacuum tube; (5) the magnetic system; (6) the supportive stand; and (7) the assembly and operation.

The most important technical aim was to build an apparatus of relatively light weight so as to make it as flexible as possible for clinical application. This task was successfully fulfilled by introducing a new type of electron gun and vacuum tube and a new core design in the magnetic system. These are described in detail. The total weight of the magnet being only 350 kg., it was possible to mount the entire unit on a vertical supportive stand which contains a counterbalancing spring arrangement for easy change in position. Provision has also been made for pendulum therapy, the excursion covering an arc of 120 degrees to each side of the vertical line for a target-axis distance which can be varied between 40 and 65 cm.

Another advantage of this unit is that it can be used for 15 mev. roentgen therapy or surface electron-beam therapy of the same energy by a simple turn of a switch.—*T. Leucutia, M.D.*

Gund, K., and Schittenhelm, R. Die physikalischen Eigenschaften der Strahlenbündel der 15-MeV-Elektronenschleuder der Siemens-Reiniger-Werke. (The physical properties of the radiation beams of the 15 mev. betatron of Siemens-Reiniger-Werke.) *Strahlentherapie*, 1953, *92*, 506–531.

The new technique used for the injection of the electrons in the 15 mev. betatron of Siemens-Reiniger-Werke permits the electrons, after they have been accelerated to the desired energy, to either impinge upon the 0.2 mm. wide platinum target thus producing a roentgen-ray beam or be taken out from the magnetically defined circular orbit in the form of a pure electron beam. The physical properties of both of these beams are discussed in detail.

Attention is paid to the following factors: (1)

characteristics inherent in constructional design; (2) equalization of the radiation fields; (3) homogenization of the dose in the irradiated field; (4) dose distribution in tissue-equivalent materials; (5) dosage in pendulum therapy; and (6) dose measurement of high energy radiations.

The following general conclusions are reached: (1) The roentgen-ray beam obtained from the 15 mev. betatron gives rise, because of its greater penetration and less side-scatter, to a more favorable dose distribution in the human body than is the case with the conventional roentgen therapy below 1 mev.; in particular, the load on the radiosensitive skin is considerably less. When pendulum therapy is used, a sharply delineated volume of tissue can be irradiated at any body depth with a uniform dose and, owing to the very steep side-contours of the beam, practically an ideal protection of the surrounding normal structures is accomplished. (2) The high energy electron beam obtained from the 15 mev. betatron can be used advantageously for the irradiation of lesions situated to within 5 cm. from the body surface. The sudden fall of the dose immediately beyond the lesion results in complete protection of the body layers lying outside of the range of the electrons.—*T. Leucutia, M.D.*

Dittrich, Wolfgang, and Schubert, Gerhard. Der Wirkungsmechanismus schneller Elektronen in biologischer Materie. (The mechanism of action of fast electrons in biologic objects.) *Strahlentherapie*, 1953, *92*, 532–554.

The authors give an exhaustive review of the literature on the effect of fast electrons on a great variety of biologic objects and compare the data thus obtained with the findings of the experimental investigations made with the aid of the 6 mev. Göttingen betatron. Their main purpose was to study and interpret the characteristic differences which are produced in many biologic objects by the action of the fast electrons and other kinds of ionizing radiations.

The opinion is expressed that the action of fast electrons, like that of all ionizing radiations, is partly direct and partly indirect. The relative biologic effect, when compared to irradiation with 200 kv. roentgen rays, was found to vary within wide limits. In the majority of the confirmed biologic reactions, however, the fast electrons have proved to be less efficient than the 200 kv. roentgen rays. This was particularly true of reactions associated with the emission of large numbers of ions due to heavier hits and the liberation of more numerous groups of free H-atoms and OH-radicals. Reactions induced by the action of lighter hits with the emission of fewer ions and the liberation of scanty groups of free H-atoms and OH-radicals, on the other hand, were observed in greater relative proportion in the irradiation with fast electrons. As is known, the 200 kv. roentgen rays produce in biologic objects an ionization of greater density than the fast electrons (see abstract this Journal, 1952, *67*, 328–329). Thus it appears that in addition to the quantitative there may also be a qualitative difference between the biologic action of the fast electrons and that of the roentgen rays of medium energy.—*T. Leucutia, M.D.*

Gärtner, H., and Peters, K. Einfluss der Dosis und Dosisleistung von Röntgenstrahlen und schnellen Elektronen auf die Mitosenhäufigkeit in Gewebekulturen. (The effect of the dose and dose rate of roentgen rays and fast electrons on the frequency of mitosis in tissue cultures.) *Strahlentherapie*, 1953, *92*, 555–562.

In former experiments Schubert and Wachsmann, and their respective co-workers, demonstrated that there is a quantitative as well as a qualitative difference between the biologic action of the fast electrons of a 6 mev. betatron and that of 200 kv. roentgen rays. The most important criterion for the quantitative evaluation was the effect on the frequency of mitosis in tissue cultures as determined from study of the fibroblasts of the chicken heart.

The authors extended these experiments by making use of the 15 mev. betatron of the Medical Clinic of the University of Erlangen. The apparatus was operated at 10.8 mev. and single doses of 250, 350, 500, 750, 1,000, 2,000, 3,000 and 4,000 r were given at a dose rate of 1,000 r/min. The cultures were fixed and examined at intervals of 3, 6, 9, 12, 15 and 18 hours after the irradiation. The data of the roentgen-ray irradiation were taken from the former experiments which likewise were carried out with a dose rate of 1,000 r/min.

The following are the authors' conclusions: (1) under the above specified conditions a dose dependence of the radiation induced mitosis-inhibition in tissue cultures was noted; (2) up to 3,000 r there was a statistically lesser effect of the fast electrons as compared to similar doses of roentgen rays, then the difference diminished and at 4,000 r it disappeared altogether; (3) the index of dose equivalence, which was 0.69 at 250 r with 10.8 mev. and 1,000 r/min., rose with increasing dose and at 4,000 r it became 1; (4) accordingly, larger doses of fast electrons were relatively more efficient than smaller doses when the same dose rate was used, whereas with roentgen rays of similar dose rate no difference was observed; (5) comparison of these findings with those formerly obtained at a dose rate of 40 r/min. gave good confirmation; (6) equal doses given at lower rates, however, proved more efficient; (7) the influence of the dose rate was separated from the time factor which is also significant for both the roentgen rays and fast electrons; (8) the method used for calculating the

time factor values was experimentally verified; (9) comparison of the time factor values as determined for the roentgen rays and fast electrons showed that the effect of the dose rate differs in the two types of radiations, and that (10) presumably this difference is due to the variation in the ionization density produced by the 200 kv. roentgen rays and the fast electrons.—*T. Leucutia, M.D.*

Bode, H.-G., Hampel, D., and Markus, B. Weitere Erfahrungen in der Geschwulstbehandlung mit schnellen Elektronen. (Further experiences in the irradiation of growths with fast electrons.) *Strahlentherapie*, 1953, *92*, 563–575.

The authors analyze the results in a series of surface tumors treated from March, 1949 to October, 1952 with fast electrons of the 6 mev. Göttingen betatron. The series includes 149 cases of carcinoma of the skin and lip, 4 cases of lymph node metastases, 10 cases of precancerous lesions and 19 cases of melanomas. They are presented in a tabular form.

The irradiation was carried out with single surface doses amounting to 1,500 r in precancerous lesions, 2,000 r in carcinomas of the skin and lip and in the superficial lymph node metastases, and to 3,000 r in melanomas. The energy used varied from 2 mev. to 3.8 mev.

The authors also give comparative curves of the volume and specific doses for 2 mev. electron-beam therapy and Chaoul roentgen therapy (60 kv., 5 cm. focus skin distance, 3 cm. diameter).

The results obtained were quite satisfactory, but the authors believe that further clinical experience is necessary before a definite answer can be given to the question of whether or not the biologic effect of the fast electrons differs quantitatively or qualitatively from that of the roentgen rays. All that can be said at present is that the greatest advantage of electron-beam therapy is the unusually favorable spatial distribution of the dose throughout the irradiated tumor.

More recently the clinical application has been extended to the 15 mev. electron-beam therapy.—*T. Leucutia, M.D.*

Nödl, F. Uber Gewebsveränderungen der menschlichen Haut nach Einwirkung von schnellen Elektronen. (On tissue changes of the human skin following the action of fast electrons.) *Strahlentherapie*, 1953, *92*, 576–589.

The author describes the histopathologic changes which were observed in sections taken at various intervals following the administration of electron-beam therapy with the Göttingen 6 mev. Betatron. In the cases studied, the irradiation was usually given with single surface doses of 1,500 r, 2 mev. and a rate of 500 or 1,000 r/min. In a few instances the the dose was raised to 2,000 r with 4 mev. and 2,500 r with 4.5 mev. The dose rate was increased only once to 1,500 r/min.

With these factors, according to Bode, an immediate skin reaction is often observed during the treatment or shortly thereafter but this usually subsides completely. After eight to twelve days an erythema sets in, which gradually develops into an ulcerative reaction lasting four to six weeks or even longer. Finally a healing results. Individual variations are observed not infrequently. This course of the skin reaction following electron-beam therapy resembles very much the two-phase evolution of the intensive roentgen erythema described by Miescher which likewise exhibits individual variations.

The microscopic findings are presented in detail and illustrated with numerous photomicrographs.

The conclusion is reached that the tissue alterations produced during the normal course of the skin reactions following the administration of a single dose of fast electrons eventually lead to the same type of late sequelae as is observed with roentgen rays. The author emphasizes the preliminary character of this report, part of which is presented with certain reservations. His aim in publishing the findings at this time is to prevent overoptimism as regards the presumed lack of skin damage with this form of therapy.—*T. Leucutia, M.D.*

Kepp, R. K. Zusammenhänge zwischen Ionisationsdichte und Zeitfaktorwirkung. (Interdependence of ionization density and effect of time factor.) *Strahlentherapie*, 1953, *92*, 590–598.

The three important factors for the therapeutic evaluation of a new kind of radiation are the spatial distribution of the dose, the biologic dose equivalence of the radiation and the effect of the time factor on the biologic reaction.

The author analyzes, on the basis of available data, the significance of these three factors by paying particular attention to the interrelationship which exists between the density of the ionization and the time factor in producing a certain biologic reaction with electron-beam therapy of 3 mev.

He summarizes his findings as follows: In multiple hit processes the time factor depends on the mean ionization density in the sense that when the biologic effect has not been fully achieved the time of recovery from the hits increases with the number of ions responsible for the hits. Since the selective action of the less densely ionizing radiations on malignant tumors is due to the presence of greater target regions in the tumor cells, radiations with a lesser mean ionization density will act even more selectively when the irradiation is slightly protracted than will the more densely ionizing radiations. Experiments with *Drosophila* eggs of 4.5 hours average age and with

Bacterium coli indicate that the ionization density plays a role in the magnitude of the biologic effect also in ultrafractionated irradiation.—*T. Leucutia, M.D.*

Markus, B., and Paul W. Über Dosismessung und Dosisverteilungen in elektronenbestrahlten Körpern. (On dose measurement and dose distributions in electron-irradiated materials.) *Strahlentherapie*, 1953, *92*, 599–611.

The authors performed extensive dose measurements and determined the dose distributions in various materials for electron-beam therapy with 2 to 5 mev.

In the present article they give a comprehensive discussion of the several problems involved. Among these are: (1) definition of the (a) dose, (b) specific dose or dose density and (c) specific dose rate; (2) measurement of the specific dose in thin layers; (3) measurement of the specific dose in large objects; (4) measurement of the dose distributions; and (5) calculation of the distribution of the specific dose in various materials.

In concluding, the authors state that the most satisfactory way to characterize a certain electron beam is to specify the actual distribution of the dose density in the irradiated medium. This procedure may be replaced by listing the following characteristic factors: (1) energy of the electrons; (2) dose density at a predetermined point of the irradiated medium, preferably the specific surface dose in erg/g or the specific dose in air above the surface in erg/g or r; (3) specific surface dose rate in erg/g-sec. or specific dose rate in air above the surface in r/sec. respectively r/min.; (4) divergence of the beam, determined by the half-value width of the beam at two different distances from the electron window or by the distance of the object from the electron window or from the scattering foils used to increase the size of the irradiation field, also by stating the kind and thickness of the window and scattering foils; (5) size of the irradiated field and (6) type of tissue irradiated.—*T. Leucutia, M.D.*

Markus, B., and Paul, W. Photographische Dosimetrie in elektronenbestrahlten Körpern. (Photographic dosimetry in electron-irradiated materials.) *Strahlentherapie*, 1953, *92*, 612–620.

The photographic method is superior to other established methods of dosimetry in measuring the distribution of the specific dose in materials irradiated with fast electrons. It permits a full isodose mapping of the effective beam as well as an accurate evaluation of the rapid drop of the dose density, especially when such drop manifests itself in more than one direction (as, for example, in case of narrow beams).

The authors have used the method extensively in working with electron beams of 2 to 15 mev. energy. In the present article they analyze the relationship which exists between the blackening of a film embedded in a certain material and the specific dose prevailing in its immediate vicinity. They also discuss the limits within which photographic dosimetry is indicated and point out the possible sources of error which may cause disturbances in blackening (fluorescence produced by the electrons, effect of scattered electrons, differential sensitivity of the emulsion, etc.).

In the beginning, the authors used ordinary roentgen films but now they prefer less sensitive films, such as the film Perutz F 04, to obviate the difficulty encountered in measuring low dose rates.

Several curves and graphs are included, expressing values of pertinent interest.—*T. Leucutia, M.D.*

Markus, B., and Paul, W. Ein Körperhöhlenrohr für Elektronenbestrahlungen mit dem Betatron. (A body cavity cone for electron irradiations with the betatron.) *Strahlentherapie*, 1953, *92*, 621–630.

For the past three years, the 6 mev. Göttingen betatron has been used mainly for electron-beam therapy of surface lesions, the maximum range of electrons in soft tissue being approximately 2.5 cm.

Very recently the authors experimented with the design of an intracavitary cone which would permit an angulation of the electron beam by the interposition of scattering foils so that treatment could be given sidewise. In the present article they discuss the theoretical foundations as well as the practical possibilities of such an arrangement and give a detailed description of a model cone which they have constructed. Schematic drawings of the scattering process produced by various foils and photometric survey maps, together with the respective isodose contours of the angulated beam, are used for illustration. The theoretical limitations of the angulation are also considered.

At the present time, the authors are investigating the practicability of a similar intracavitary cone for the angulation of the electron beam of the new 15 mev. betatron.—*T. Leucutia, M.D.*